DRAFT
Salmon, Steelhead and Bull Trout in Water Resources Areas 37, 38 & 39: An Interim Strategy for Stock Recovery and Project Prioritization

Prepared For:

Yakima River Basin Salmon Recovery Board Lead Entity

Prepared By:

ENTRIX, INC.
Olympia, Washington

PROJECT NO. 354803

November 1, 2001

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Salmon, Steelhead and Bull Trout in Water Resources Areas 37, 38 & 39: An Interim Strategy for Stock Recovery and Project Prioritization

Prepared For:

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Intensive statewide salmonid recovery efforts were recently initiated following the listing of several Columbia River and Puget Sound stocks under the Endangered Species Act. Washington State House Bill 2496 directs the Washington Conservation Commission to assemble technical advisory groups (TAGs) of local watershed experts to identify habitat factors limiting salmonid production in each of the major watersheds in the state. The limiting factors assessments conducted under SHB 2496 yield generic "action" recommendations to sustain and/or rehabilitate habitat needed for healthy salmonid populations. These action recommendations do not necessarily address which of the limiting factors are *most* limiting to the salmon populations within a watershed. However, they can be used as a tool by which local governments, land owners, tribes, and non-profit organizations can identify and promote specific on-the-ground salmon recovery projects that may be funded through the Governor's Salmon Recovery Funding Board (SRFB). The SRFB was created in 1999 by the Washington Legislature to guide the spending of state funds targeted for salmon recovery projects.

Landowners and other stakeholders desiring funding for acquisition, restoration or assessment-based projects must submit applications for SRFB funding through the Yakima River Basin Salmon Recovery Board (YRBSRB) Lead Entity for the specific watershed resource inventory area(s) (WRIA) for which the Lead Entity has jurisdiction. The boundaries of the YRBSRB Lead Entity incorporate Water Resource Inventory Areas (WRIAs) 37, 38 & 39 (Figures 3-1 through 3-3). The City of Selah is recognized by the Governor's SRFB as the manager of the YRSRB Lead Entity. The YRSRB Lead Entity includes representation from the jurisdictions of Benton, Yakima and Kittitas counties, the Yakama Nation, and all city jurisdictions within WRIAs 37, 38 and 39. It is the role of each watershed's Lead Entity to prioritize projects that best represent the statewide goals and guidance for salmon recovery (JNRC 2001), and the unique characteristics of the local watershed and salmonid populations within it. Therefore, it is the purpose of this document to provide SRFB applicants with the strategy the Yakima Lead Entity –the Yakima River Basin Salmon Recovery Board(YRBSRB) will use to prioritize projects to be considered for SRFB funding. The strategy for project prioritization discussed in this document focuses on the aquatic habitat and resources located within the Lead Entity boundary, comprised within WRIAs 37, 38 and 39.

The project prioritization strategy represented here reflects:

1) Our current understanding of the habitat factors limiting salmonid production within WRIAs 37, 38 and 39.

2) The underlying causes of these conditions (to the extent they are known), and

3) The projected response of the salmon stocks of interest to proposed restoration projects (JNRC 2001).

The primary objective of this strategy document is to provide applicants appropriate guidance in their project applications to maximize the potential for effective salmon recovery through funded projects. Applications for project funding can be obtained on line at: www.wa.gov/iac/downloads/manual%2018.pdf. Project applications submitted to the SRFB via the Lead Entity will, in part, be evaluated based on how effectively they address limiting factors identified in this strategy. However, because the LFA for the Yakima watershed is still in draft form, and because the methodologies applied for LFAs throughout the state do not identify the *most* limiting factor to salmon by species and life stage, the LFA does not necessarily represent the most complete scientific findings on salmon habitat in the watershed. Therefore, in this strategy we have also considered the most recent information on reach conditions in the watershed as compiled through the joint efforts of the University of Montana and Central Washington University (Snyder and Stanford 2000), and through the ongoing Ecosystem Diagnostics and Treatment (EDT) study directed by the Yakama Indian Nation. It is expected that this strategy will be modified on an annual basis to reflect updated information on ecological conditions in the Yakima watershed from these and other efforts as they become available.

2.0 MISSION, GOALS AND OBJECTIVES FOR SALMON RECOVERY IN THE YAKIMA WATERSHED

2.1 Mission Statement

To identify, propose and support projects, water quality and quantity programs and land management actions that yield tangible, sustainable and measurable benefits to salmonid health and habitat in the Yakima watershed.

2.2 Goals Of Salmon Habitat Restoration in the Yakima Watershed

- To develop and implement a credible, science-based process for identifying salmon habitat recovery projects in the Yakima watershed.
- To submit a list of prioritized project proposals to the Salmon Recovery Funding Board that meets statewide, regional and local goals for salmon recovery.
- To increase community involvement and leadership of salmon recovery efforts within the YRBSRB Lead Entity boundaries hydrologic and ecological linkages between reaches in the Yakima watershed such that a longitudinal continuum of habitat units that support the freshwater life history strategies of all salmonid species in the Yakima watershed can be sustained.

2.3 Objectives Of The Yakima River Basin Salmon Recovery Board

- Identify and encourage project sponsors to apply for SRFB funds for credible projects.
- Provide clear guidance to potential project sponsors to solicit funding for priority salmon habitat recovery projects.
- To educate community members and stakeholders on the requirements and limitations to salmon in the Yakima River basin to ensure that project applications are biologically founded.
- To rehabilitate habitat factors that may limit salmonid production in waters of the Yakima River watershed.
- To preserve functioning habitat important for salmonid production in waters of the Yakima River watershed.
- To eliminate data gaps of importance for understanding salmonid production and recovery in waters of the Yakima watershed.
- To work with adjacent watershed groups, stakeholders, and state, federal, local, and tribal governments to coordinate salmon recovery projects that maximizes efficiency and cost effectiveness.

3.0 APPLICATION REQUIREMENTS AND SCHEDULING INFORMATION

3.1 General Requirements for Project Eligibility

- Projects to be prioritized for funding through the strategy discussed in this document must lie within the jurisdictional boundaries overseen by the Lead Entity. The boundaries of this Lead Entity incorporate WRIAs 37, 38 & 39 (Figures 3-1 through 3-3).

Figure 3-1. WRIA 37 Basin Map

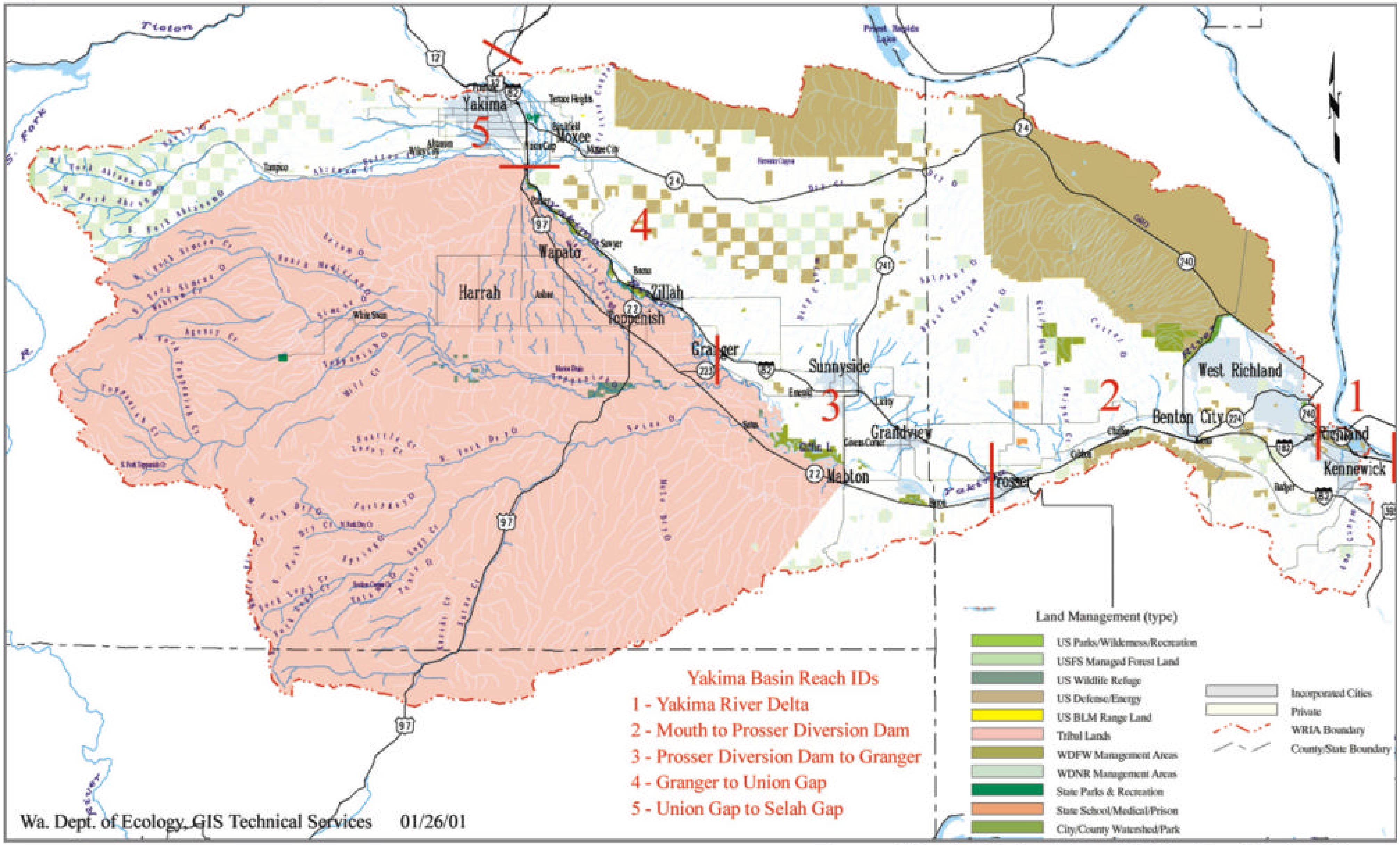

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Figure 3-2. WRIA 38 Basin Map

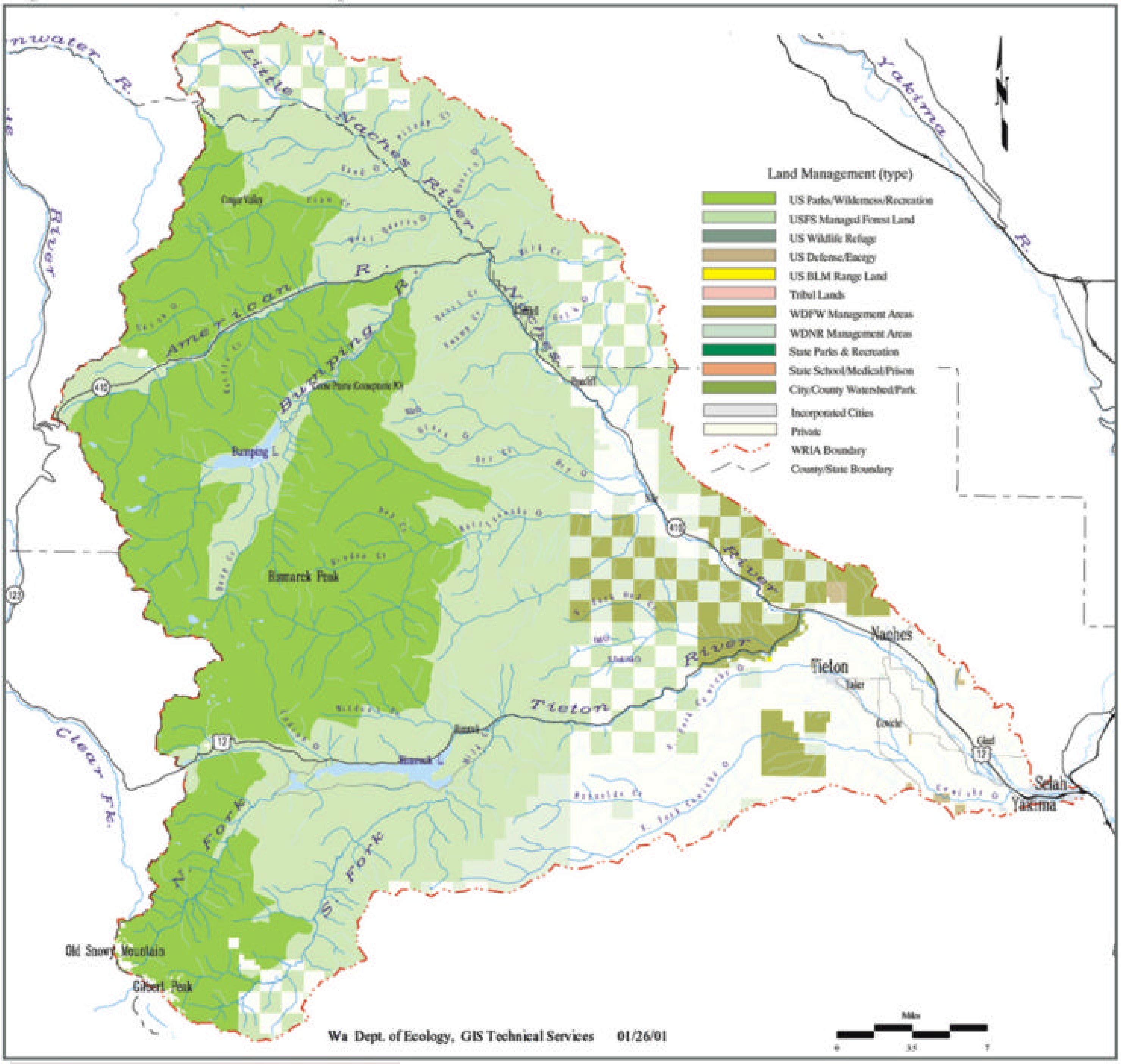

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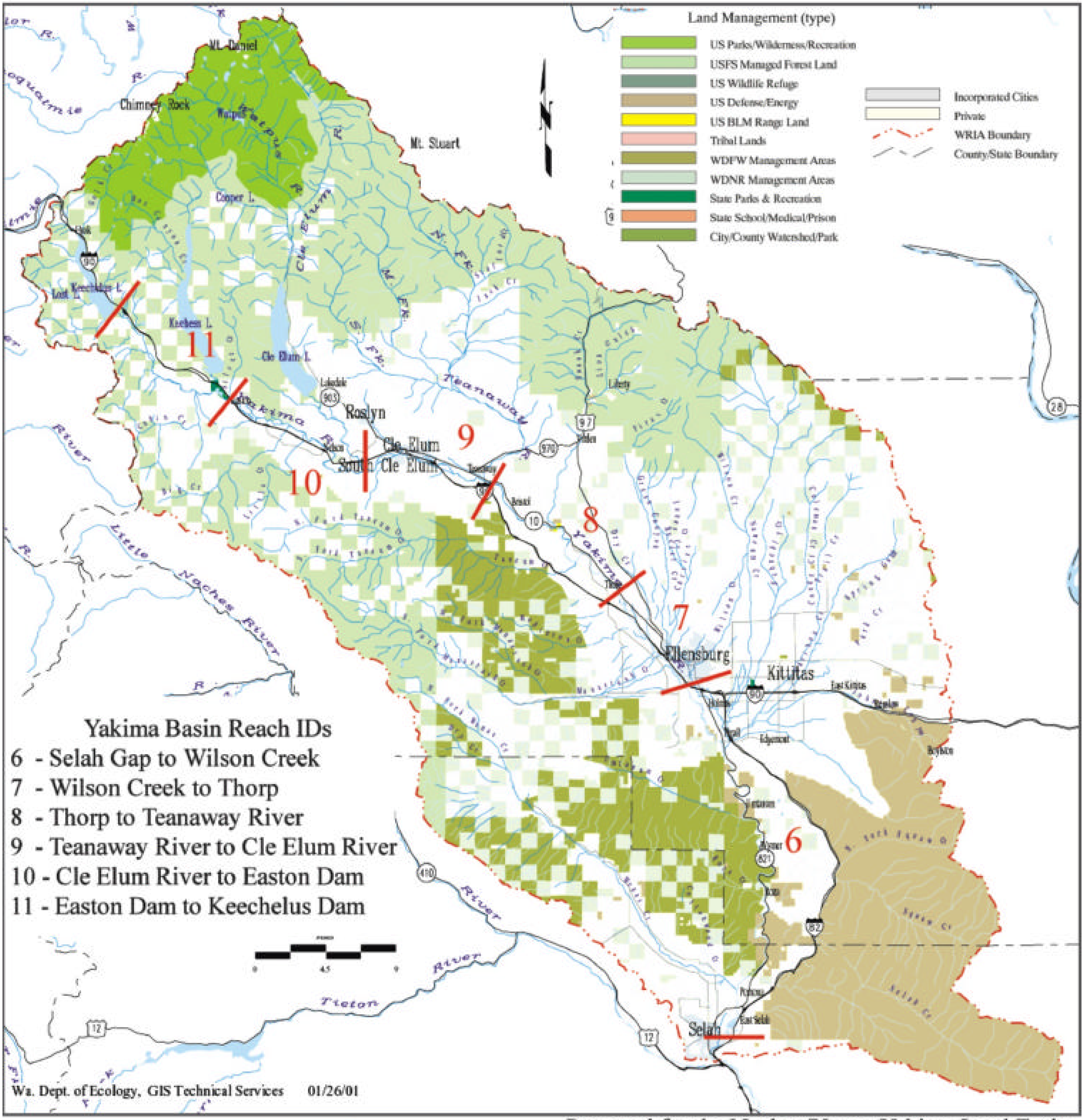
Figure 3-3. WRIA 39 Basin Map



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3.2 Project Categories Identified for Funding by SRFB

Specific project categories for funding have been established by the SRFB (JNRC 2001). According to the SRFB, potentially funded projects should be categorized under the general project types of: (1) acquisition, (2) in-stream diversions, (3) in-stream passage, (4) in-stream habitat, (5) riparian habitat (6) upland habitat, (7) estuarine/marine near-shore, (8) assessments and studies, and (9) combination. Table 3-1 provides a summary of the project categories relevant to the YRBSRB Lead Entity area.

Table 3-1 2001 Salmon Recovery Funding Board Project Categories and Examples Relevant to the Yakima Watershed

Project Category	SRFB Definition	Examples
Acquisition	Rights or claims may be acquired, provided the value can be established or appraised.	• Purchase of land • Access • Utilization of rights in fee title or by perpetual easement
In-Stream Diversions	Items that affect or provide for the withdrawal and return of surface water to include the screening of fish from the actual water diversion, the water conveyance system, and the by-pass of fish back to the stream.	• Diversion dam • Fish by-pass • Fish screen: gravity and pump • Headgate • Pipes and ditches
In-Stream Passage	Affect or provide fish migration up and downstream to include road crossings, barriers, fishways, and log and rock weirs.	• Bridge • Carcass placement • Culvert improvements • Dam removal • Debris removal • Diversion dam • Fishway • Log control (weir) • Mobilization • Rock control (weir) • Roughened channel • Traffic control • Water management
In-Stream habitat	Items that affect or enhance fish habitat below the ordinary high water mark of the water body. Items include work conducted on or next to the channel, bed, bank, and floodplain by adding or removing rocks, gravel, or woody debris.	• Bank stabilization • Carcass placement • Channel connectivity • Channel reconfiguration • Complex log jams • Deflectors/barbs/vanes • Dike removal/setback • Livestock fencing/crossing • Log or rock control (weirs) • Off-channel habitat • Plant removal/control • Riparian plant installation • Roughened channel • Spawning gravel placement • Wetland restoration • Woody debris placement

Project Category	SRFB Definition	Examples
Riparian Habitat	Freshwater, marine near-shore, and estuarine items that affect or will improve the riparian habitat outside of the ordinary high water mark or in wetlands.	• Livestock fencing • Livestock stream crossing • Livestock water supply • Plant removal/control • Riparian plant installation • Wetland restoration
Upland Habitat	Items or land use activities that affect water quality and quantity important to fish, but occur above the riparian or estuarine area.	• Alternate water source • Erosion control (road and slope) • Impervious surface removal • Livestock fencing • Low/no till agriculture techniques • Pipes and ditches • Plant removal/control • Riparian plant installation • Road abandonment/ decommissioning • Sediment collection ponds
Assessments and Studies	The results of proposed assessments must directly and clearly lead to identification, siting, or design of habitat protection or restoration projects. Assessments intended for research purposes, monitoring, or to further general knowledge and understanding of watershed conditions and function, although important, are not eligible for SRFB funding.	• Feasibility studies • Channel migration studies • Reach-level, near-shore, and estuarine assessments • Barrier inventories • Unscreened water diversion inventories • Landslide hazard area inventories
Combination Projects	Projects that include both planning and assessments.	• acquisition and restoration • enhancement elements or acquisition and non-capital

The above projects identified within each of the SRFB funding categories simply represent examples. The evaluation of projects proposed in the above categories will be dependent on the sub-watershed/reach priority and the numeric evaluation of the project relative to the other projects proposed within the sub-watershed (section 5.0).

3.3 Eligibility

Projects to be funded by the SRFB can be proposed by any non-for-profit organization or individual. Typical sponsors could include:

- Cities
- Counties
- Tribes

- Regional Fisheries Enhancement Groups
- Conservation Districts
- Special Purpose Districts
- Private Landowners

3.4 2001/2002 Schedule for SRFB Funding

- Nov. 30, 2001: Lead Entity submits prioritized project list to SRFB
- Jan-Feb, 2002: SRFB tech. review team meets with lead entity to review applications
- March 18-April 18: SRFB recommends projects
- April 19: funds allocated

3.5 Ineligible Projects in 2001/2002

- Mitigation projects
- Capital Facilities and Public Works Projects
- Purchase of non-essential buildings/land
- Fishing license buyback
- Monitoring, maintenance and stewardship as stand-alone projects
- Operation /construction of fish hatcheries

4.0 HABITAT & STOCK STATUS IN THE YAKIMA WATERSHED

4.1 Overview of Salmon Habitat Needs

Although the numeric habitat thresholds necessary for productive salmon habitat continue to be debated, there is broad consensus that salmon require:

- cool, clean, well-oxygenated water,
- in-stream flows that mimic the natural hydrology of the watershed, maintaining adequate flows during low flow periods and minimizing the frequency and magnitude of peak flows (stormwater),
- clean spawning gravels not clogged with fine sediment or burdened with toxic chemicals,
- presence of in-stream pools that will support juvenile rearing and resting areas for returning adults,
- abundance of in-stream large woody debris, particularly large key pieces, that provide cover, create pools, and provide habitat diversity,
- unobstructed migration for juveniles and adults to and from their stream of origin,
- broad, dense riparian stands of mature conifer that provides cover, shade, LWD recruitment, etc., and
- estuarine conditions that support production of prey organisms for juvenile outmigrants as well as for rearing and returning adults.

The draft Limiting Factors Assessment (LFA) (WCC May 2001), sub-basin summary (NWPPC 1988), and ecological synthesis review (Snyder and Stanford 2000) have grossly characterized habitat conditions within the Yakima watershed in relation to the requirements needed for salmonid production detailed in section 4.1. The information contained in these assessments was based on review of the literature, and the collective understanding of local experts familiar with the watershed and its subwatersheds. The conclusions presented in these documents were not always supported with data from site-specific studies. An overview of the general habitat conditions, as presented in these and other references, is summarized below.

4.2 Watershed Condition Summaries in WRIAs 37, 38 and 39

The draft LFA for the Yakima River watershed (WCC May 2001) identified 11 categories of factors that may limit the movement and reproduction of salmonid populations. These limiting factors include: (1) flow control, (2) floodplain connectivity, (3) sedimentation, (4) large woody debris (LWD), (5) riparian habitat, (6) fish passage barriers, (7) entrainment, (8) channel condition, (9) water quality, (10) juvenile habitat, and (11) general habitat quality. Most of these factors affecting salmonid production are present at multiple watershed locations, suggesting that throughout the Naches and Yakima River watersheds similar types of actions may be taken to improve stream conditions for anadromous species. The major limiting factors identified in the Yakima watershed (as of May 2001) are summarized in Table 4-1. This table is intended to be illustrative of the breadth of conditions that should be addressed throughout the watershed to remedy many of the habitat problems. Specific locations within sub-basins where such actions are required are described in greater detail in the LFA (WCC 2001).

Table 4-1. Limiting factors toSalmonid Production in WRIAs 37, 38 & 39 and recommended actions to improve production

Limiting Factor	Recommended Action	Limiting Factor Mechanism	Sub-watershed where applicable
Flow Control	Eliminate hydropower diversions whenever in-stream flows are downstream and cannot be maintained.	Contributes to decreased habitat and increased water temperature that favors predation by bass and northern pike minnow.	Yakima, Cle Elum, Naches, and Tieton[1] Rivers
Flow Control	Increase/restore in-stream flows for rearing and adult passage and/or decrease diversions for agriculture.	Reduces summer low flow concentrating trout and salmon for predation plus increased water temperatures favors predation species by bass and northern pike minnow.	Toppenish Creek, Yakima, Naches, Tieton[1], and Cle Elum Rivers and Wenas, Taneum, Big, Lmumma (Squaw), Manastash, Taneum, and Wilson[2] Creeks, Simcoe (multiple locations), Ahtanum Creek
Flow Control	Implement water conservation methods on farms and improve irrigation system.	Reduces summer low flow concentrating trout and salmon for predation plus increased water temperatures favors predation species by bass and northern pike minnow.	Yakima, Tieton[1], and Naches Rivers and Wenas, Lmumma (Squaw), and Wilson[2] Creeks
Flow Control	Develop/Restore a "normative" flow regime.	Reduces spawning for spring chinook; reduces access for juveniles to off-channel habitat during periods of low flow.	Ahtanum Creek, Yakima, Naches, Teanaway[3] River, Cle Elum, and Tieton[1] Rivers and Taneum and Swauk Creeks
Flow Control	Maintain hydrologically mature watershed.	Maintains low summer base flows and natural hydrology.	Teanaway[3] River, Little Naches[4] River, Rattlesnake[5] Creek, and Cabin Creek
Floodplain Connectivity	Restore floodplain function in historic anastomosing reaches.	Reduces off channel rearing habitat and diversity and limits groundwater, hyporheic, and surface water interactions in floodplains.	Yakima River, Bumping[6] River, Teanaway[3] River, Swauk Creek, Big Creek, and Nile Creek, Simcoe Creek
Floodplain Connectivity	Relocate roadways in floodplains to the outside edge of floodplains.	Reduces off-channel rearing habitat and habitat diversity from roads along river and tributaries and in floodplains.	Naches River, Tieton[1] River, Bumping[6] River, Rattlesnake[5] Creek, and Oak Creek
LWD	Restore LWD presence to provide in-stream habitat diversity and cover; restore LWD transport downstream.	Currently, little in-stream LWD exists.	Yakima, Naches, Tieton[1], Teanaway[3], Kachess[7], and Little Naches[4] Rivers and Swauk, Big, Cabin, Manastash, Wilson[2] Creek, and Taneum Creeks, Ahtanum Creek
LWD	Preserve riparian forest for natural LWD recruitment in the long term.	Future sources of long term LWD are limited.	Wilson[2] Creek and Oak Creek
LWD and	Restore LWD and	Currently, there is poor transport of	Yakima, Bumping[6], Cle Elum,

Limiting Factor	Recommended Action	Limiting Factor Mechanism	Sub-watershed where applicable
Sediment (gravel) Recruitment	sediment transportation downstream in tributary dams and diversions.	LWD and sediment (gravel) by dams.	Kachess[7], and Tieton[1] Rivers
Riparian	Restore riparian condition.	Currently, there is a lack of future LWD source and shading potential.	Snipes/Spring Creeks, Sulphur Creek, Satus Creek (and its tribs), Simcoe Creek, Marion Drain (Wanity Slough), Ahtanum Creek, Yakima mainstem, Bumping[6], Little Naches[4] River, and Teanaway[3] Rivers and Taneum, Swauk, Big, Cabin, Wenas, Lmumma (Squaw), Roza, Umtanum, Manastash, and Wilson[2] Creeks
Riparian	Prevent livestock access to stream.	Riparian grazing reduces channel quality and increases sediment load.	Ahtanum Creek, Yakima River, Wenas Creek, Cowiche Creek and Umtanum Creek
Fish Passage: advisability/feasibility	Develop policy on whether to encourage or discourage salmonid utilization of habitat.	Current access may attract salmonids into unfavorable habitat where they can become trapped. In many cases, adults should be precluded entirely from such habitat.	Corral Canyon Creek, Snipes Creek, Spring Creek, Sulphur Creek
Fish Passage: Barriers	Restore anadromous fish passages, improve fish passage at diversions, culverts, and dams that are partial barriers.	Barriers to fish habitat minimize the total area for spawning and rearing.	Yakima, Tieton[1], and Naches Rivers and Tucker, Cowiche, Rattlesnake[5], Oak, Gold, Lost, Swamp, Wenas, Umtanum, Manastash, Taneum, Roza, Wilson[2], Big and Cabin Creeks, Ahtanum Creek, Toppenish Creek, Simcoe Creek (narrows diversion), Wide Hollow Creek
Entrainment: entrapment	Install fish screens on all diversions.	Currently, there is stranding of juveniles in irrigation ditches due to improperly screened irrigation diversions.	Satus Creek, Toppenish Creek (waterfowl ponds, pump, etc.), Cowiche Creek, Manastash Creek, and Big Creek, Simcoe Creek (multiple locations), Marion Drain (Wanity Slough), Ahtanum Creek, Wide Hollow Creek
Entrainment: attraction flows	Reduce/eliminate mechanism causing false attraction flows of adults.	There is stranding of adults due to false attraction flows.	Yakima River, Snipes Creek, Spring Creek
Channel Condition	Correct erosion of channel.	Channel banks are eroding from activities in the riparian zone or high flow rates.	Rattlesnake[5] Creek, Nile Creek
Channel Condition	Restore and maintain channel migration zone.	Reduces current limited interaction between channels and migration zones.	Little Naches[4] River, Ahtanum Creek
Water Quality: Toxics	Reduce toxics loadings.	Toxics loadings potentially cause negative effects on fish health and survival. Toxics reduce habitat available for rearing.	Snipes Creek, Spring Creek, Toppenish Creek, lower Satus Creek, Granger Drain, Moxee Drain
Water	Improve hydrologic and	Limits growth, activity, and food	Snipes Creek, Granger Drain,

Limiting Factor	Recommended Action	Limiting Factor Mechanism	Sub-watershed where applicable
Quality: Dissolved Oxygen	habitat conditions to increase dissolved oxygen content.	supply (carrying capacity). Extremely depressed levels can result in mortality.	Marion Drain (Wanity Slough)
Water Quality: nutrients	Implement BMPs to reduce nutrient contributions.	Contributes to eutrophication of waters, favoring non-native predatory species, and contributing water quality degradation.	Satus Creek and tribs., Marion Drain, Granger Drain, Moxee Drain, Wide Hollow Creek
Water Quality: Fine Sediment (from land use practices)	Reduce sediment contribution from farms by use of TMDL, erosion control BMPs (e.g., livestock fencing), and improving and consolidating small irrigation districts.	Erosion from farms increases sediment load into the system.	Yakima River mainstem, Wilson[2] Creek, Dry Creek, and Swauk Creek, Satus Creek and tribs., Snipes/Spring creeks, Sulphur Creek, Marion Drain, Moxee Drain, Toppenish Creek, Simcoe Creek, Marion Drain, Granger Drain, Moxee Drain, Wide Hollow Creek
Water Quality: Fine Sediment (from roads)	Implement Road Management strategy to control sediment; properly maintain and size culverts.	Currently, there is excess sediment entering the system from logging road usage; an accumulation of fine sediment in gravel impedes spawning activities.	Rattlesnake Creek, Little Naches[4] River, Kachess[7] River, Taneum Creek, Wilson[2] Creek, and Squaw Creek, Ahtanum Creek, Wide Hollow Creek
Water Quality: Temperature	Avoid/regulate release of warm water.	High temperatures downstream can stress salmonids resulting in reduced disease resistance, and displacement from otherwise suitable habitat.	Lower Yakima River, Bumping[6] River, Granger Drain, Moxee Drain
Juvenile Habitat	Maintain or re-introduce beaver activity.	Beavers create quality juvenile habitat.	Roza Creek, Lmumma (Squaw) Creek and Swauk Creek
Quality Habitat	Protect quality habitat.	Preserves existing good habitat.	Naches River

[1]Tieton River includes Fish Creek
[2]Wilson Creek includes Badger, Cherry, Naneum and Coleman Creeks
[3]Teanaway River including Jack, Jungle and DeRoux Creeks
[4]Little Naches River including Crow, Quartz, Bear and Blowout Creeks
[5]Rattlesnake Creek including Little Rattlesnake, Hindoo, Wildcat and Little Wildcat Creeks
[6]Bumping River including American and Union Rivers
[7]Kachess River including Box Canyon Creek

Water and Sediment Parameters

Sedimentation and Embeddedness

The condition of spawning redds in salmon habitat is a critical factor in salmonid stock reproduction. A number of studies have shown a correlation between the ratio of fine sediments in spawning gravels and the survival of salmonid embryos in redds (McNeil and Ahnell, 1964; Cooper 1965; Irving and Bjornn, 1985). The reason for this effect may be that fine sediments prevent the delivery of well-oxygenated water to embryos (by clogging inter-gravel spaces) and/or restrict the escapement of alevins from the redd via cementation. These studies have also shown a correlation between extent of forest-related activities (logging and road construction) and the accelerated delivery of fine sediment to streams within the watershed. Further, McNeil and Ahnell (1964) and Irving and Bjornn (1985) have indicated that salmonid survival to emergence decreases significantly when fine sediments (<1.0 mm diameter) in spawning substrate exceed 20%.

Watson (1991) studied sediment characteristics of the upper Yakima River basin and collected data regarding existing levels of fine sediment, geometric mean particle size, and dissolved oxygen in spawning gravels to be used for making management decisions related to timber harvest. Samples were collected from mid-August through mid-October, 1990, from three spawning riffles from each of the 19 tributaries. The results of the Watson (1991) study included the identification of "Red Light" (statistically significant exceedances of a sediment screening threshold of >25% fines <1.0 mm) and "Yellow Light" (approaching statistical exceedances of sediment screening threshold i.e., >15% fines <1.0 mm) tributaries. The sole "Red Light" tributary identified was North Fork Manastash Creek. The "Yellow Light" tributaries included: Cabin Creek, Cole Creek, Gold Creek, Little Creek, South Fork Manastash Creek, Taneum Creek, North Fork Taneum Creek. Tributaries for which statistical exceedances of sediment screening thresholds were not yet evident included: Big Creek, West Fork Teanaway River, North Fork Teanaway River, Middle Fork Teanaway River, Box Canyon Creek, French Cabin Creek, Kachess River, Cle Elum River, Mineral Creek, and Log Creek.

While spawning gravels do not appear to be limited in the upper river, the effects of irrigation dams, removal of floodplain deposits, and levying can affect sediment recruitment to the basin overall (Snyder and Stanford 2000). Downcutting from revetment provides some evidence that sediment recruitment has been interrupted in several locations within the watershed. Irrigation dams, in turn, can interrupt sediment transport to the lower river, potentially affecting the quantity and integrity of spawning gravels in the lower basin. The factors affecting gravel recruitment to the basin overall are poorly understood in the Yakima watershed.

Dissolved Oxygen

Because high levels of dissolved oxygen (DO) are critical to salmonid reproduction, Watson (1991) also reported DO concentrations (as % saturation) for the sampled tributaries. The tributaries that had DO values of <90% saturation included: Log Creek, North Fork Manastash Creek, South Fork Manastash Creek, and Taneum Creek. Dissolved oxygen concentrations can be particularly problematic in the lower basin and its tributaries. The principal cause of reduced dissolved oxygen is elevated temperatures and high biological and chemical oxygen demand from anthropogenic water quality contamination.

Toxics

An evaluation of potentially toxic analyte concentrations in water, bed sediments and fish tissues from the Yakima River was conducted by Johnson et al (1986). As part of this study, samples were collected from four Yakima River locations (Cle Elum, Wymer, Buena and Kiona/Benton City) and a number of tributaries. The Cle Elum and Wymer sample locations in this study are located upstream of the City of Yakima, whereas the other concentrations of total DDTs (DDx), 15 additional persistent organochlorine pesticides, PCBs and mercury were reported for all samples. DDx, dieldrin and endosulfan were detected in a number of water samples, but almost exclusively in tributaries (DDE and dieldrin were detected only once in the main stream). The predominant organochlorines detected in the Yakima River bed sediments were DDx and dieldrin. Maximum concentrations were detected in sediments from Sulfur Creek (234 ppb DDx; 14.9 ppb dieldrin). One high hit of aldrin (1,065 ppb) was present in the sediment sample from Spring/Snipes Creek. Both Sulfur Creek and Spring/Snipes Creek, however, are downstream of the City of Yakima.

Based on an analysis of their data and results of USGS studies, Johnson et al (1986) resolved that the source of DDx and dieldrin in the Yakima River Basin is primarily from historical agricultural use (i.e., rather than from illegal use) and occurs primarily during irrigation season. The authors subsequently recommended that erosion control measures be implemented to reduce losses of DDx and dieldrin from agricultural land in the Yakima River Basin.

Another study examining constituent concentrations in aquatic media was conducted by Fuhrer et al. (1998a) who reported concentrations of trace elements in stream water, suspended sediments, bed sediment, soil, and aquatic biota collected from the Yakima River Basin between 1987 and 1991. These authors examined the spatial and temporal distribution of trace elements in the aquatic environment, including antimony (Sb), arsenic (As), barium (Bs), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), mercury (Hg), nickel (Ni), selenium (Se), silver (Ag) and zinc (Zn). As discussed below, this study also examined temporal variations in concentrations in aquatic biota sampled at sites sampled in common in 1989 and 1990.

The findings of the Fuhrer et al. (1998a) study were as follows:

1) Most of the element enrichment in the Yakima River Basin results from natural geologic sources in the forested landscapes of the Kittitas and mid-Yakima Valley – primarily in the Cle Elum, Upper Naches, Teanaway and Tieton Subbasins. These subbasins typically have water and sediment element concentrations that are 4- to 100-times greater than in areas farther downstream in the Yakima River Basin.

2) Distribution of element concentrations that increase in areas affected by human activities include As, Cd, Cu, Pb, He, Se, and Zn.

3) Loads of Arsenic (As) associated with agricultural practices increase dramatically during the irrigation season. The primary sources are the Sulfur Creek Wasteway and Wide Hollow Subbasin, both of which are downstream of the City of Yakima.

4) Comparisons between suspended and dissolved As loads indicate that the annual dissolved-arsenic loads at fixed sites in the lower Yakima Valley are from 4- to 9-times higher than their respective suspended loads.

Although water and sediment conditions in some areas of WRIAs 37, 38 and 39 appear to be significantly impacted by sedimentation and/or chemical inputs, most of these areas are located in the lower Yakima River (WRIA 37). It is not known if the elemental enrichment reported for the upper reaches of the Naches and Yakima rivers (WRIAs 38 & 39) ultimately poses a threat to aquatic life. Because the primary source of the elemental (metal) enrichment is from natural geological weathering, it is possible that the annual mass loadings reported reflect normal, historic conditions for those waterways. However, hydrologic manipulations of flow in these watersheds alter the seasonality of these enrichments in an unnatural manner and the effects of these alterations on basin productivity are poorly understood.

As reflected in the summaries above, water quality concerns in WRIA 37 are more numerous and several reaches within WRIA 37 have been placed on the 303(d) list for a variety of chemical and physical constituents. The water quality conditions in the lower basin affect all anadromous salmonids passing through this zone during their migration phases. Principal water quality issues in this zone include suspended sediment, temperature, flow, DDx, PCBs, fecal coliforms, ammonia, and a variety of pesticides (see Snyder and Stanford 2000 for review). These water quality issues have directly affected salmonid health in this area (e.g., lethal summer temperatures), and have also indirectly affected the survival of salmonids throughout the Yakima watershed by favoring non-native predatory species more tolerant of these conditions (e.g., smallmouth bass). Tissue concentrations of several of the pesticides found in bass within this area exceed human health standards, and as a result, the ability to control these predator populations through recreational harvest is also compromised. Additionally, the effects of flip-flop flow regulation as reviewed by Snyder and Stanford (2000) have drastically altered basin hydrology. Cool ground water contributions to summer baseflows have been interrupted and peak discharge conditions have been largely dampened (Figure 4-1). The lower Yakima River is probably the most significantly affected by the increased temperatures of groundwater entering the river in the summer.

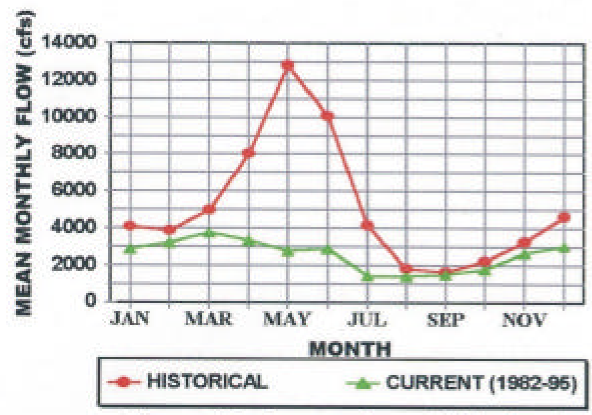

Figure 4-1. Comparison of historical and contemporary mean monthly flows in the low Yakima River.

Fish Stock and Aquatic Life Surveys

The Naches and Yakima River watersheds support a diversity of biota including resident and anadromous fish species and their prey. Ecological surveys of the Naches and Yakima River basins were conducted by Cuffney et al (1997) as part of the National Water-Quality Assessment Program (USGS) at 25 sites in 1990 including 14 upstream of the City of Yakima. Of the 14 upstream sites, 5 were located in the Naches River or its tributaries, and 9 were located in the upper Yakima River or tributaries. The goals of the surveys were: 1) to assess water quality conditions based on fish, benthic invertebrate, and algal communities; 2) to determine the hydrologic, habitat, and chemical factors (i.e., metals and organopesticides) that affect the distributions of these organisms; and 3) to relate physical and chemical conditions to water quality.

The findings reported by Cuffney et al. (1997) included:

1) Fish communities of headwater streams in the Cascades (upstream extreme of Yakima and Naches Rivers and tributaries) and Eastern Cascades (mid-reaches of the Naches R. and tributaries) ecoregions of the Yakima River Basin were primarily composed of salmonids and sculpins, with cyprinids dominating in the rest of the basin (WRIA 37);

2) The most common of the 33 fish species taxa collected were speckled dace, rainbow trout, and Paiute sculpin;

3) Invertebrates presented the highest number of taxa (193), and sensitive insect species (e.g., mayflies, stoneflies, and caddisflies) formed the majority of the invertebrate communities of the Cascades and Eastern Cascades regions;

4) Diatoms dominated algal communities throughout the basin (134 algal taxa were found on submerged rocks, the only stream microhabitat sampled);

5) Sensitive red algae and diatoms predominated in the Cascade and Eastern Cascade ecoregions, whereas the abundance of eutrophic diatoms and green algae was large in the Columbia Basin ecoregion (i.e., mid- and lower-reaches of the Yakima River and tributaries, and lower reaches of the Naches River and tributaries) of the Yakima River Basin;

6) Ordination of physical, chemical and biological site characteristics indicated that elevation was the dominant factor determining the distribution of biota; agricultural intensity and stream size were of secondary importance;

7) Three community types were identified by ordination: a) high elevation, cold-water communities associated with low agricultural intensity; b) lower elevation, warm-water communities associated with low agricultural intensity; and, c) lower elevation, warm-water communities associated with moderate to high agricultural intensity—particularly found in the lower watershed sites (WRIA 37);

8) Multimetric community condition indices indicated that Cascade and Eastern Cascade sites were largely unimpaired; however, all but 2 sites in the Columbia Basin site group (WRIA 37) were impaired;

9) Agriculture (nutrients and pesticides) was considered the primary cause of this biotic impairment, and all impaired sites were characterized by multiple indicators of impairment;

10) Large-river group sites downstream of the City of Yakima were all moderately to severely impaired;

11) High levels of impairment at large-river sites corresponded with high levels of pesticides in fish tissues and the occurrence of external abnormalities;

12) Response exhibited by invertebrates and algae to a gradient of agricultural intensity suggested a threshold response for sites in the Columbia Basin site group: community conditions declined precipitously at sites with moderate agricultural intensity and showed little response to higher levels of agricultural intensity. This pattern of response suggested that mitigation efforts conducted at sites with high levels of agricultural intensity may not produce meaningful improvements in invertebrate and algal community conditions. In contrast, relatively moderate mitigation efforts at sites, where the level of agricultural intensity is near to the impairment threshold, will probably produce large improvements in community conditions at relatively modest costs.

Studies focusing exclusively on the fish stocks present in the Naches and Yakima Rivers have also been conducted. Pearsons et al. (1996) conducted biological surveys within the Yakima River Basin and collected data describing the life history of rainbow trout and interactions between trout and other fish species. Major findings of the study included:

1) Although age 0+ rainbow trout and spring chinook were associated with bank habitats in the Yakima during spring, summer, and fall, few were observed in the middle of either mainstem or in side-channel habitats.

2) The number of fish and fish species captured in Swauk Creek and the immigration of rainbow trout and spring chinook decreased with increasing elevations; and annual variations in assemblage structure did not appear to differ among sites.

3) Spatial distribution of rainbow redds in the Yakima River was patchy, with most observed in reaches with unconstrained channels and abundant instream cover.

4) Large tagged rainbows tended to move downstream more often than upstream, but more fish were recaptured at upper elevations.

5) Temporal variability of rainbow trout abundance in tributary index sites ranged from stable to highly fluctuating. Average (year 1994) densities ranged from $0.12/m^2$ (Swauk Creek) to $0.01/m^2$ (Cabin Creek). Trout densities in 5 index sections of the Yakima averaged 297/km during 1994 and were not as temporally variable as tributary sites. All juvenile chinook salmon were observed in sites less than 730 meters elevation.

6) Variation in assemblage structure was larger in space than in time in tributary and mainstem index sites.

7) Hatchery-reared steelhead released into the Northfork Teanaway subbasin behaviorally dominated rainbows probably due to their larger size. Displacement

of wild trout by hatchery steelhead within channel units, and densities and biomasses of wild rainbows appeared negatively influenced by hatchery steelhead. Residual steelheads were relatively abundant in 1994 and were released in an area containing wild bull and rainbow trout.

8) Results from competition experiments performed in the north and middle forks of the Teanaway River suggest: 1) hatchery-reared steelhead negatively impacted growth of naturally produced rainbow but not of chinook; 2) hatchery-reared chinook negatively impacted growth of wild chinook; and 3) wild chinook did not impact the growth of wild rainbows.

Another fish sock study was conducted by Hindman et al. (1991) who surveyed multiple reaches of the Yakima River and reported on the identity and numbers of species present. Their data indicated that the greatest number of large spawning rainbow trout occurred in the lower mainstem and lower elevation tributaries (Umatanum, Cherry, Wilson, and Naneum Creeks). Conversely, higher elevation tributaries and mainstem areas contained fewer and smaller (although not necessarily younger) trout. The authors note that most of the current anadromous fish (e.g., steelhead, chinook salmon) spawning is known to occur here, although their data indicate that few large rainbows utilize the upper Yakima River (WRIA 39) for spawning (Hindman et al., 1991).

Finally, Johnson et al. (1986) collected Yakima River resident fish as well as spring chinook and out-migrating juvenile salmonids and analyzed whole fish, muscle tissue and eggs for organochlorine and selected inorganic residues. Detected residues included DDT, DDE, dieldrin, and polychlorinated biphenyls (PCBs; specifically, Aroclor 1260). Concentrations were higher in samples collected from lower river stations than in samples collected from the upper Yakima River. At all locations, however, total DDx, dieldrin, Aroclor 1260, and mercury tissue residues were below FDA action levels (5,000 ppb DDx; 300 ppb dieldrin; 2,000 ppb PCBs; 1,000 ppb Hg). Furthermore, all concentrations in eggs were below the literature-based “effects thresholds” identified by the authors. Not unexpectedly, concentrations in salmonid tissue were substantially lower than those of resident species, likely due to the transitory nature of the exposure to anadromous species.

The actions tabulated above address specific mechanisms and factors identified for sub-watersheds within the Yakima River to be, at least in part, limiting for the production of salmonids. On a broader scale, many of the actions identified in Table 4-1 also address the watershed-scale limiting factors identified by Snyder and Stanford (2000), as detailed below:

(1) Fluctuation or dewatering of the channel complex during base flow.

(2) Reduction in habitat heterogeneity and flood plain connectivity.

(3) Alteration of the natural temperature regime.

(4) Impairment of water quality (TMDL).

(5) Negative interactions between fish species (wild vs. exotic and wild vs. hatchery).

4.3 Stock-Specific Status and Distribution Overview

The following stock information was paraphrased from Fisher and McArthur (2000) and the Yakama Nation (Yakama Nation 1997 *as cited in* Dunnigan 2000), and is useful background in recognizing the needs of specific stocks in this recovery strategy.

<u>Bull Trout</u>

The Yakima River population of bull trout is considered a distinct stock within the threatened Columbia River distinct population segment (DPS). The status of Yakima River bull trout is considered critical based on chronically low numbers of fish encounters (WDFW and WWTIT 1994, Busby et al. 1998). Native char inhabiting the upper river are believed to be fish that have outmigrated from the upper river tributaries as juveniles or were flushed out of upper river headwater reservoirs. The upper Yakima River fluvial population is comprised of fish that inhabit the mainstem between Rosa Dam and the Cle Elum, Kachess, and Keechelus dams. Isolated resident populations are recognized within the North Fork Teanaway River, Ahtanum Creek, Bumping Lake, Cle Elum Lake, Kachess Lake, and Keechelus Lake (Busby et al. 1998). These stocks are considered at risk of stochastic extirpation due to their inability to be refounded, their single life-history form, their low abundance, and their limited spawning area (Busby et al. 1998). Construction of dams without fish passages and unscreened irrigation diversions, and increased temperatures caused by development along shorelines and diking are the major factors responsible for the critical status of this species in the Yakima watershed.

The most recent survey data for bull trout in the Yakima basin identified only 4 bull trout, distributed over 2 redds in the headwaters of the river, the location where bull trout density is greatest (Anderson 2000).

<u>Steelhead Trout</u>

Summer-run Yakima River steelhead are a distinct stock based on their geographical isolation. No winter-run steelhead utilize the Yakima River. Yakima River steelhead are part of the mid-Columbia ESU, and are hence considered ‘threatened’ under the ESA. The population status of Yakima steelhead is considered depressed based on fish passage counts at Prosser Dam, and on sport/Tribal estimates (WDFW and WWTIT 1994). Native steelhead escapement into the Yakima was below the 2,000 fish goal for 11 out of the 12 years between 1980 and 1992 (WDFW and WWTIT 1994). Historically, the Yakima River produced an estimated 80,000 to 100,000 adult steelhead annually, but the total annual run size is now around 1,700 fish. In the past five years, the escapement reaching the upper Yakima basin (above Rosa Dam) has not exceeded 125 fish. There may be significant introgression with resident and/or hatchery steelhead introduced in the basin.

Coho salmon

Wild stocks of coho salmon *Oncorhynchus kisutch* were once widely distributed within the Columbia River Basin (Fulton 1970; Chapman 1986). However, coho salmon probably went extinct in the Yakima River in the early 1980s (Yakama Nation 1997 *as cited* in Dunnigan 2000). Efforts to restore coho within the Yakima basin rely largely upon releases of hatchery coho. The feasibility of re-establishing coho in the Yakima basin may initially rely upon the resolution of two central issues: the adaptability of a domesticated lower river coho stock used in the re-introduction efforts and associated survival rates, and the ecological risk to other species associated with coho re-introduction efforts.

The Yakama Nation has released 85,000 to 1.4 million coho smolts in the Yakima River watershed annually since 1985. Prior to 1995, the primary purpose of these releases was harvest augmentation; after 1995, the primary purpose became a test of the feasibility of re-establishing natural production. Currently, the Yakima coho program is part of the Yakima Klickitat Fisheries Project (YKFP). The Yakama Nation is also the lead agency for coho re-introduction project in the Wenatchee and Methow sub-basins. Although the mid-Columbia coho re-introduction project and the YKFP are administered by separate entities within the Yakama Nation, each project relies on the transfer of information between basins to some degree to resolve critical uncertainties that are not considered basin-specific issues.

Chinook salmon

Chinook salmon in the Yakima basin are not currently listed as threatened or endangered under the ESA, although numbers are substantially depressed relative to historic population figures. Historical abundance of chinook salmon in the Yakima basin probably ranged from about 38,000 to 100,000 fish. These figures are based on two documents: Kreeger and McNeil, 1993 and the Yakima Subbasin Plan (Anonymous., 1990). Kreeger and McNeil (1993) argue that 3.8% of the historical run of salmon and steelhead in the entire Columbia Basin should have been produced by the Yakima Basin because it represented 3.8% of the historical Columbia Basin watershed. On the basis of a moving average of peak historical Columbia River catch data and assumed exploitation rates, they estimate that the historical run of summer chinook, and of spring and fall chinook combined, was on the order of 2.7 million and 2.0 million fish, respectively. If 3.8% of all spring and fall chinook entered the Yakima, the historical run to the Yakima Basin would have been 76,400. It is often assumed that the historical summer chinook run was twice as large as either the spring or the fall chinook runs, which were approximately equal in size. If this held true for the Yakima, the historical run of fall chinook was about 38,000 fish. The Yakima Subbasin Plan bases its considerably higher estimate on the amount of suitable spawning habitat for chinook historically present in the Yakima Basin, and the area taken up by a typical chinook redd. This approach yields estimates of ~200,000 for spring chinook and ~200,000 for summer and fall chinook combined. If summer and fall chinook, whose spawning distributions overlapped broadly, were assumed equally abundant, the historical abundance of fall chinook would have been on the order of 100,000 fish.

5.1 Overview of Project Priority Screening Methods

Guidance provided by the Governors Salmon Recovery Board (JNRC 2001), suggests that projects selected for funding by the SRFB should lie within those sub-watersheds or reaches that are most in need of protection or restoration on the basis of: (1) their existing ability to support salmon (i.e., salmon strongholds), (2) their critical importance to the preservation and conservation of native stocks (i.e., recognized ESUs), and (3) their potential to yield measurable and sustainable increases in native salmonid use after implementation. Although both native and wild stocks reproduce naturally in the wild in WRIAs 37, 38 and 39, native stocks are unique populations that possess a distinct gene pool generally specific to a watershed with relatively predictable gene frequencies of certain quantifiable traits. In contrast, the genetics of wild stocks are hatchery-derived. Such "wild" populations were either deliberately or inadvertently introduced from hatchery operations within the watersheds.

In recognition of the importance of preserving the remaining native stocks and their linkages to general habitat quality in WRIAs 37, 38 and 39, a two-tiered approach to project prioritization will be utilized to evaluate projects for potential funding by the SRFB. The two tiers of this scoring system include:

Tier 1: Sub-watershed or Reach Prioritization

Tier 2: Project scoring and prioritization within a reach

Sub-watershed and/or reach prioritization as specified under Tiers 1 and 2 is often possible if specific studies, such as those provided from Ecosystem Diagnosis and Treatment (EDT) analyses, have been conducted. In many cases, however, such reach examinations have not been conducted or completed and sub-watershed and/or reach prioritization cannot be factored into the ultimate scoring of a project.

Tier 2 numerically ranks projects on the basis of their benefits to specific species and life stages, and overlays a weighting of sub-basins and/or reaches based upon the geographic importance of the reach/sub-watershed. Under Tier 2, projects are evaluated on the basis of their ability to protect and/or improve the success of specific life history functions of a specific stock(s) of salmonids. Thus, the scoring template stresses biological functionality only. The geographic and reach prioritization referenced in Tiers 1 and 2 is factored into the total project score through a weighting system applied as a product to the total (cumulative) project score. The ability to implement a project that scores highly through this process will be decided subsequently by the Technical Advisory Group (TAG) in their final screening process prior to application submittal. Thus, the Tier 2 project scoring exercise yields specific project scores that can be compared against scores from other proposed projects within a watershed for their overall biological benefits to salmonid stocks in the Yakima basin. In general, projects with the following characteristics should score highly through the Tier 2 template:

- Native stocks will benefit over introduced stocks.
- Project addresses action item(s) focused on the most habitat factor for the species and life stage *most limited* in a reach/sub-watershed.
- Project addresses that the source (i.e., causation) of a limiting habitat factor will generally be scored higher than those that address symptoms only.
- Project benefits more than one salmonid species and thereby promotes biodiversity.
- Project provides, conserves, or enhances access to more critical salmon and steelhead habitat than another proposed project in the same sub-watershed/reach.
- Project restores non-functional habitat by linking to currently functioning habitats; habitat units will be linked in a priority that reflects those closest together first before those that are spread out.

5.2 Tier 1: Sub-watershed/Reach Prioritization

Tier 1 sub-watershed prioritization in the Yakima watershed represents a slight modification of the categorization schema used by the Upper Columbia Salmon Recovery Board. Geographic prioritization of sub-watersheds and reaches under this schema is split into four categories as follows:

Category 1:

These sub-watersheds represent systems that most closely resemble natural, fully functional aquatic ecosystems. In general they support large, often continuous blocks of high-quality habitat and sub-watersheds (tributaries) supporting multiple populations. Connectivity among sub-watersheds and through the mainstem river corridor is good, and contains more than two species of federally listed fish. Exotic species may be present but are not dominant. Protecting the functioning ecosystems in these sub-watersheds is a priority. Habitat complexity and flow regimes in these watersheds are sufficient and diverse to support multiple salmonid species. Given the existing functionality in Category 1 sub-watersheds/reaches, the most appropriate projects are usually those that protect these properly functioning habitats through a combination of easement and/or landowner agreements, conservancy programs, or property purchase.

Category 2:

These sub-watersheds support important aquatic resources, often with watersheds classified as strongholds for one or more populations throughout. Category 2 sub-watersheds have an increased level of fragmentation relative to Category 1 watersheds from habitat disturbance and/or loss. These watersheds have a substantial number of sub-watersheds where native populations have been lost or are at risk for a variety of reasons. At least one federally listed fish species can be found within the sub-watershed/reach. Connectivity among sub-watersheds within Category 2 watersheds may still exist or could be restored within the watershed so that it is possible to maintain or rehabilitate life history patterns and dispersal. Restoring ecosystem functions and connectivity within these sub-watersheds are priorities. Such restoration projects in these watersheds should address causal mechanisms, such as land-forming processes, such that restoration projects are long-lived and relatively maintenance free.

Category 3:

These sub-watersheds may still contain significant habitat that supports salmonids. In general, however, these sub-watersheds have experienced substantial degradation and are highly fragmented by extensive habitat loss, most notably through loss of connectivity with the mainstem corridor. At this time, the opportunities for restoring full expression of life histories for multiple populations found within the watershed are limited. An assessment of the production potential and habitat conditions is often warranted to best identify where restoration could best serve overall production in these sub-watersheds. Therefore, projects in the SRFB "assessment" category are often the most appropriate for this group of sub-watersheds, although restoration projects focused on fixing long-term source problems could also score highly. As with Category 2 sub-watersheds/reaches, restoration projects in Group C sub-watersheds/near-shore HU's should address causal mechanisms for habitat degradation, so that any habitat restoration projects implemented are long-lived.

Category 4:

These sub-watersheds contain both functional and non-functional habitats that historically supported populations of one or more federally listed species. Exotic species may now be dominant in one or more sub-watersheds, and native species are typically not present in sustainable numbers.

5.3 Sub-watershed and Reach Priorities in the Yakima Watershed

Two significant studies are underway to better define habitat conditions of the Yakima watershed. These efforts represent the most rigorous analyses of habitat on a reach scale conducted to date within the Yakima watershed. The first effort has developed broad scale reach delineations of the mainstem based upon hydrological and geomorphic characteristics (Snyder and Stanford 2000, Draft). The second effort has been undertaken by the Yakama Nation to identify habitat potentials based upon the EDT modeling process. The EDT process provides greater resolution at the reach scale. Results from both of these studies have not been finalized, so final consideration of their results in this strategy is requisite upon their completion. Notwithstanding, at the time of writing of this draft strategy, EDT diagnostics have been completed for chinook salmon throughout the basin and its major tributaries (Watson 2001), and the hydrologic/geomorphic reach delineations established by Snyder and Stanford (2000) are not expected to change.

Reach delineation is effective at identifying the natural characteristics of the river basin such that projects aimed at restoring salmon habitat can be distributed to areas with the highest potential for sustaining and/or improving conditions for salmon, steelhead and/or bull trout. No published documentation of reach scale delimiters are yet available from the EDT modeling exercises ongoing by the Yakama Tribe, so they will not be described in this draft. Because the reach delineation exercise conducted by Snyder and Stanford (2000) is in a draft-final form, a summary of these reach break-outs is appropriate and potentially useful for project applicants.

The following reach descriptions defined originally by Snyder and Stanford (2000), were reproduced from the draft LFA for the Yakima basin (Haring 2001, WCC 2001):

Reach 1—Yakima River Delta: The natural delta of the Yakima River is highly altered because of pooling upstream of McNary Dam. The lower 2.1 miles of the historic Yakima River are inundated, reducing the extent of historic distributaries and off-channel rearing areas.

Reach 2—Mouth to Prosser Diversion Dam (RM 0.0 to RM 47.1): A single meandering channel with few braids or mid-channel islands characterizes this reach. The channel has downcut over time, isolating the channel from the adjacent floodplain. The reach from the mouth to Kiona (RM 29) was identified as the main fall chinook spawning area (CBSP 1990), although the report indicated that it was difficult to assess spawning utilization due to turbidity during spawning. However, WDFW has developed new techniques of estimating fall chinook spawning escapement in the lower Yakima, and has successfully done so since 1998 (Watson 2001). Other anadromous salmonids use this reach only for overwintering and migration because of high summer water temperatures.

Reach 3—Prosser Diversion Dam to Granger (RM 47.1 to RM 82.8)—The upper 17 miles of this reach includes side channels, backwater areas, and diverse habitat types; the downstream 18 miles are characterized by a low-gradient single channel with little habitat diversity (Snyder and Stanford 2000). Satus and Toppenish creeks are the two major tributaries in this reach, with additional significant inflow from groundwater and irrigation return drains.

Reach 4—Granger to Union Gap (RM 82.8 to RM 106): This reach is considered one of the most structurally complex and diverse sections of the Yakima River (Snyder and Stanford 2000). For most of the reach, the highway constrains the floodplain on the west side of the river, whereas the other side of the floodplain is in a semi-natural state with numerous side-channels, braids, and backwater areas.

Reach 5—Union Gap to Selah Gap (RM 106 to 116.4): This reach borders the City of Yakima and is characterized by numerous side-channels, islands, and backwater areas. However, dikes confine the full extent of the natural floodplain through much of this reach.

Reach 6—Selah Gap to Wilson Creek (RM 116.4 to 147.0): The river is confined in a canyon through the upper portion of this reach, with no side-channel complexes, few islands, and only a few backwater areas. As the river leaves the lower end of the canyon, it flows across a deep alluvial floodplain that has been heavily mined for gravel. The river is confined through this portion of the reach by dikes and bank protection, with little in-channel complexity.

Reach 7—Wilson Creek to Thorp (RM 147.0 to RM 163.0): This reach flows through the Ellensburg valley (Snyder and Stanford 2000). The channel is constrained on one side by the highway, and there is some flood control diking at several locations. At the lower end, there are braided channel complexes with some side-channels.

Reach 8—Thorp to Teanaway River (RM 163 to 176.1): The river is confined in this reach as it flows through the Ellensburg Canyon

Reach 9—Teanaway River to Cle Elum River (RM 176.1 to 185.6): This reach is primarily a large main channel, with some side channels (Snyder and Stanford 2000). The channel is mainly confined by the highway and railroad berms.

Reach 10—Cle Elum river to Easton Dam (RM 185.6 to 202.5): Tributaries in this reach include Spex Arth Creek, Peterson Creek, Little Creek (RM 194.6), Big Creek (RM 195.8), Tucker Creek (RM 1999.9), and Silver Creek (RM 201.9) (WDFW 1998). The reach is considered to be a high quality area for spawning and rearing, characterized by numerous side channels, complex structures in the channel, and good riparian vegetation (Snyder and Stanford 2000). There is some housing development within the floodplain in this reach.

Reach 11—Easton to Keechelus Dam (RM 202.5 to 214.5): Tributaries in this reach include Kachess River (RM 202.5), Cabin Creek (RM 203.5), Hudson Creek, Cedar Creek, Stampede Creek, Telephone Creek, Mosquito Creek, Swamp Lake Creek, and Price Creek (WDFW 1998). This reach is characterized by numerous side channels, logjams, and braided channels, and is considered to be high quality spawning and rearing habitat with little influence from development (Snyder and Stanford 2000). The channel has an excellent riparian corridor, with a lot of complex in-channel structure.

Snyder and Stanford (2000) prioritized some of the above reaches for conservation in the following order:

1. Upper Yakima: reaches 9, 10 and 11
2. Kittitas Valley: reach 7 and lower reach 8
3. Yakima City (Union Gap): reach 5
4. Upper and lower Naches River: reaches not considered above
5. Wapato: reach 4
6. Selah: reach 6
7. Yakima mouth: reach 1
8. Athanum Creek: sub-basin not considered in mainstem reach breaks listed above.

The above reaches, as delineated by Snyder and Stanford, have been categorized by their functionality for the purposes of this strategy in Table 5-1. It is presumed that the reach/sub-watershed categorizations depicted below will be altered following TAG review of this draft strategy.

Table 5-1 Mainstem Yakima Reach and Sub-watershed Categories

Tier 1 Category	Snyder & Stanford Mainstem Reach or Sub-watershed
1	mainstem reaches 5, 7, 8, 9, 10, 11; upper and lower Naches River; *subwatersheds to add*
2	mainstem reaches 1, 4, & 6; Ahthanum Creek; *subwatersheds to add*
3	Mainstem reaches 2 & 3; *subwatersheds to add*
4	Water quality impaired drains-*to add*

Final determination of the appropriateness of reach delineations for prioritizing Yakima watershed recovery-based projects will require discussion with the technical advisory group (TAG) that will administer this strategy; however, for the interim, and for the scoring template described in section 5.4, the reach priorities above are considered valid. For projects within sub-watersheds where reach priorities have not been established, further analysis is required. Results from the EDT modeling ongoing by the Yakama Nation could prove particularly useful in this endeavor.

5.4 Tier 2—Project Scoring Overview, Rationale and Execution

Project evaluations within specific sub-watersheds and/or reaches within the Yakima basin will involve an interpretation of the anticipated fish population response after the project has been implemented. This interpretation will be conducted using a quantitative scoring method that reflects the benefits of each project on specific life history functions of the species that would most benefit from the project. Briefly, the scoring method addresses the biological functions provided by specific projects for the species of importance to overall salmon recovery in the Yakima watershed and weights project scores based on: (1) the geographic importance of the sub-basin/reach to salmon recovery where the project would occur, and (2) the potential for the project to increase native and wild stock production (use) based on the area of useable or improved salmon habitat provided, and (3) the certainty of success/habitat quality modifier (a “stressor” qualifier of the total score).

The project scoring protocol involves answering a series of iterative yes/no questions. High scoring projects should generally support (benefit) significantly more fish than lower scoring projects. Table 5-2 represents an initial iteration of the project scoring template that could be used to evaluate potential projects for their biological functionality and their conformance with the overall salmon recovery strategy objectives of WRIAs 37, 38 and 39. The questions proposed in Table 5-2 are in draft form and are subject to modification by the TAG. The scoring protocol borrows from the Indicator Value Assessment (IVA) method initially developed for addressing wetland functions (Hruby et al. 1995). It deviates substantially from this model in the type of questions asked, and the manner by which the data are ultimately used—to characterize the value of potential salmon restoration projects. It also differs in the application of weighting factors to the final score that normalize a potential project's score relative to: (1) the amount of habitat created from the project, (2) the geographic prioritization of the sub-watershed/reach for overall salmon recovery where the project is proposed, and (3) the certainty of outcome. Full rationale for project scoring of each question and the weighting factors applied is provided in Appendix A.

The geographic prioritization of the watersheds within WRIA's 37, 38 and 39 reflects the overall salmon recovery strategy geared towards maximizing the native stock enrichment of steelhead, bull trout and chinook salmon. The enhancement or re-establishment of naturally produced but hatchery-derived chinook and coho salmon is of lesser importance but still valid within the context of salmon recovery for the Yakima basin. This species prioritization is reflected in the project scoring template (Table 5-2). It should be considered a "given" that a sustained increase in any salmonid population following project implementation would reflect "recovery" as recognized by the SRFB.

As indicated, the Tier 2 project scoring method characterizes the biological functionality created by potential projects through the answering of a series of yes/no questions. The maximum score for each question posed for a species is '5'. The cumulative score for all species that could benefit is then tallied for each question. The number of species that could benefit will vary by the geographic location of the project within the WRIA, based upon known existing and potential use. While the questions primarily address the biological functionality created/preserved, restored, or assessed by specific projects, there are elements to the scoring that reflect the objectives of the overall strategy (i.e., focus on native stocks) and may therefore be in contrast to a straight-forward interpretation of biological functionality. Thus, the following premises should be considered while addressing the questions to evaluate specific projects.

- The maximum score for each question may vary by species, in reflection of the variation in life history behaviors and habitat use by the different species in the Yakima basin and the designation of the species under the ESA. Maximum scores for the four species evaluated are as follows: steelhead = 5, bull trout = 5, chinook salmon = 4, coho salmon = 3.

- "Yes" answers are given to each question if the project is closely associated with the biological function indicated in the question.

- In general, "yes" answers to questions focused on protection/preservation-based projects receive maximum scores possible for the species in question. This rationale is in keeping with the overall salmon recovery strategy objective of conserving currently functional habitats, and is also consistent with the goals and objectives of the Salmon Recovery Funding Board (JNRC 2001).

- In general, "yes" answers to questions focused on restoration-based projects receive slightly lower scores than the maximum possible for the species because the restoration of habitat to a functional status has greater uncertainty (and often cost) than preservation/protection-based projects. Some exceptions to this rule are seen in the scoring template, as explained in Appendix A where applicable.

- In general, "yes" answers to questions focused on assessment-based projects receive the lowest scores for each species because habitat assessment projects are generally considered less essential to salmon recovery at this stage in the recovery process. However, as with some types of restoration-based projects, there are some types of assessment projects where this "rule" is deviated because of a specific need for the information, and the necessity of filling the data gap before subsequent restoration or preservation-based projects can be initiated. These exceptions are explained in Appendix A.

Each project will be evaluated through the scoring template (Table 5-2) and a total score obtained from the following equation as follows (1):

(1) Total Project Score

= (SS)(WF1)(WF2)(WF3)

where:

- SS = sum of scores for each question presented in the project scoring template (Table 5-2). In addition to the biological functionality addressed by the questions in the project scoring template, the scores for each question reflect: (1) the species priority strategy for salmon recovery in the Yakima watershed, and (2) the SRFB guidance and strategy emphasis on protection-based projects over restoration and assessment-based projects. Thus, if a project benefits an element of habitat important to steelhead and bull trout as well as coho, then all species/stocks will receive scores for the question addressing the habitat element, but the steelhead and bull trout will receive the highest score for the question because of their higher priority level.

- WF 1 = Tier 1 sub-watershed/reach weighting factor. For projects in Tier 1/Category 1 sub-watersheds/reaches, multiply the unitless sum of scores (SS) by 1.3, in Tier1/Category 2 sub-watersheds/reaches, multiply SS by 1.2, in Tier1/Category 3 sub-watersheds/reaches multiply SS by 1.1, and in Tier 1/Category 4 sub-watersheds/reaches multiply SS by 1.0.

- WF 2 = area estimate of aquatic habitat created/protected by project. This areal estimate should include all in-channel surface area (i.e., to include the bankfull width of the channel) and riparian habitat protected, plus a quotient of the upland habitat that may be included in the project (esp. important for acquisition projects). *For the present, the maximum riparian width will be assumed to be 300 ft for the uppermost Yakima basin (mainstem and tributaries above reach 7), 200 ft in reaches 6 and 7, and 150 for all other reaches; these widths can be adjusted upon TAG review of validity.* Upland habitat protected/restored in association with a salmon recovery project will be assigned a credit at $1/10^{th}$ of that of aquatic and riparian habitat. Thus, following the calculation of SS*WF1*WF2 a net estimate of *functional* habitat area created by a project is determined. This areal estimate should be expressed in units of square footage.

- WF 3 = certainty/habitat quality modifier. This modifier is applied to the equation to reflect several elements of uncertainty that may be associated with a proposed project. These elements of uncertainty include:

    a) The record of the project proponent in completing past projects.

    b) Unique elements of the habitat that may not otherwise be reflected in SS (e.g., project located in key spawning habitat).

    c) The certainty of the long-term viability of the project. This is generally a reflection that the project addresses causal mechanisms of habitat impairment as opposed to symptoms of habitat impairments.

WF 3 modifiers should be applied to the score of (SS)(WF1)(WF2) as follows:

→WF 3 = 1.0—if the project proponent has a good record in completing projects in the past, if the habitat elements supported by the project are particularly limiting in the sub-watershed where the project would occur, or if there is high confidence (91-100% certainty) that the project will remain viable for the long term.

→WF 3 = 0.66—if the project proponent has a mixed record in completing projects, if the habitat where the project would occur offers habitat of use to the priority species for recovery but the habitat type is not particularly limited in the sub-watershed, or if there is less confidence in the long term viability of the project (75-90% certainty).

→WF 3 = 0.33—if the project proponent has a marginal record in completing projects of similar nature in the past, if the project would benefit habitat that is neither used by priority salmonids or is unlimited in the sub-watershed, or if the confidence in the long term viability of the project is better than random (50%), but less than 75%.

The wide spread in the WF-3 quotient should ensure adequate spread in project scores to differentiate amongst the different projects scored. It will be up to the TAG, upon review of project applications, to determine the appropriate quotient for the WF 3 factor.

Table 5-2. Draft* Project Scoring Template.

	HABITAT PATHWAY	Chinook	Coho	STHD	Bull Trout	Probable Functions[1] (F,S,M,H,R)	Total Score Possible[2]
	HYDROLOGY (surface water, groundwater)						
1a	project protects/preserves perennial stream or spring flows	4	3	5	5	F,R,M,S	17
1b	project restores perennial stream or spring flows (e.g., via water right trade)	3	2	4	4	F,R,M,S	13
1c	project assesses functions of freshwater spring or stream flows (e.g., IFIM)	2	1	3	3	F,R,M,S	9
2a	project protects against future groundwater withdrawals	2	1	3	3	F, R, M	8
2b	project restores groundwater source by permanently eliminating water right	4	3	5	5	F, R, M	17
	WATER QUALITY (temp., d.o., susp. sediments, toxics)						
3a	project protects against potential shoreline erosion through riparian planting, other natural bioengineering or land acquisition/easement	4	3	5	5	F, S, H, R	17
3b	project restores or stabilizes erosion-prone shoreline habitat	3	2	4	4	F, S,R,H	13
4a	project would protect against water temperature increase (e.g, land purchase)	3	2	4	4	H, M, F, R, S	13
4b	project would restore habitat to yield lower temperatures over time	4	3	5	5	H, M, F, R, S	17
4c	project assesses temperature conditions to determine production potential	2	2	3	3	H, M, F, R, S	10
5a	project would protect against future loss in d.o. percent saturation	3	2	4	4	H, M, F, R, S	13
5b	project would restore d.o. saturation to naturally achievable levels	4	3	5	5	H, M, F, R, S	17
5c	project would assess d.o. saturation levels to determine prod. potentials	2	1	3	3	H, M, F, R, S	9
6a	project protects against future introduction of contaminant source	3	2	4	4	F, S,R,H	13

HABITAT PATHWAY		Chinook	Coho	STHD	Bull Trout	Probable Functions[1] (F,S,M,H,R)	Total Score Possible[2]
6b	project restores water quality by reducing or eliminating contaminant source	4	3	5	5	F, S,R,H	17
6c	project assesses contaminant source fate and transport	2	1	3	3	F, S,R,H	9
IN-CHANNEL HABITAT (lwd, spawning gravel, pool/riffle ratios)							
7a	project protects or promotes lwd recruitment/retention	4	3	5	5	F, R, S	17
7b	project restores lwd densities in area where natural retention should exist	3	2	4	4	F, R, S	13
7c	project assesses lwd loading on basis of geomorphic constraints of stream	21	1	3	3	F, R, S	9
8a	project protects against spawning gravel scouring and/or embedding	4	3	5	5	S, F, H	17
8b	project restores spawning gravels to area where natural retention should exist	3	2	4	4	S, F, H	13
8c	project assesses spawning gravels	2	1	3	3	S, F, H	9
HABITAT ACCESS							
9	project protects habitat access under all flows	4	3	5	5	M, S, F, R, H	17
10a	project restores juvenile access under high flows	2	1	3	3	M, S, F, R, H	9
10b	project restores juvenile access under mean flows	3	2	4	4	M, S, F, R, H	13
10c	project restores juvenile access under low flows	4	3	5	5	M, S, F, R, H	17
11a	project restores adult access under high flows	2	1	3	3	M, S, F, R, H	9
11b	project restores adult access under mean flows	3	2	4	4	M, S, F, R, H	13
11c	project restores adult access under low flows	4	3	5	5	M, S, F, R, H	17
12	project assesses habitat access/factors affecting upstream distribution	2	1	3	3	M, S, F, R, H	9

HABITAT PATHWAY		Chinook	Coho	STHD	Bull Trout	Probable Functions[1] (F,S,M,H,R)	Total Score Possible[2]
FLOODPLAIN CONNECTIVITY/RIPARIAN CONDITION							
13a	project protects floodplain connectivity (e.g., acquisition)	4	3	5	5	S, F, M, R, H	17
13b	project restores floodplain connectivity (e.g., dike breaching)	3	2	5	5	S, F, M, R, H	15
13c	project assesses floodplain connectivity	2	1	3	3	S, F, M, R, H	9
14a	project protects riparian corridor	4	3	5	5	S, F, M, R, H	17
14b	project restores riparian corridor function	3	2	4	4	S, F, M, R, H	13
14c	project assesses riparian corridor function	2	1	3	3	S, F, M, R, H	9

[*] It is assumed that questions will be modified, added or removed following review by the technical advisory group

[1]Functions (listed in order of probable importance for project type): F--feeding, R - refuge; S - spawning, M- Migration, H – health

[2]Total score of a project determined from the following equation: Score = SS(WF1)(WF2)(WF3). SS = sum of individual scores for each question. WF 1 = Tier 1 Weighting Factor; WF2 = Area Estimator Weighting Factor; WF 3 = Certainty Weighting Factor:

WF 1: TIER 1 sub-watershed/reach categories: multiply total score by 1.3 for projects in Category 1 sub-watersheds/reaches, 1.2 for Category 2 sub-watersheds/reaches , 1.1 for Category 3 sub-watersheds/reaches and 1.0 for Category 4 sub-watersheds.

WF 2: Multiply score from above calculation by area made accessible/created by the project. Area includes all aquatic and riparian habitat created.

WF 3: "Stressor" calculation: multiply total habitat area created by certainty of outcome of project to increase salmonid habitat after implementation. (0.33, 0.66 or 1.0--see text).

As referenced in the report and annotated bibliography.

1992. Yakima River Basin Fisheries Project Draft Environmental Impact Statement.

Abernethy, C. Scott et al., September 1990. Velocity Measurements at Three Fish Screening Facilities in the Yakima Basin, Washington, Summer 1989, Annual Report 1989. Pacific Northwest Laboratory.

Anderson, E. 2000. Washington Department of Fish and Wildlife, Personal Communication to Jeff Fisher. Regarding: survey data of bull trout in the Yakima River Basin. September 14, 2000.

Busby et al., 1998. Columbia River Bull Trout Status Report. U.S. Fish and Wildlife Service.

Chapman. 1986. Salmon and Steelhead Abundance in the Columbia River in the 19^{th} Century. Transaction of the American Fisheries Society 115: 662-670.

Cuffney et al., 1997. Distribution of Fish, Benthic Invertebrate, and Algal Communities in Relation to Physical and Chemical Conditions, Yakima River Basin, Washington, 1990. USGS Water Resources Investigations Report 96-4280. Raleigh, North Carolina.

Eitemiller. 2000. Anthropogenic Alterations to an Alluvial Floodplain within the Yakima River Basin, Washington. Central Washington University.

Fast D., et al, Yakima Indian Nation Fisheries Resource Management. May 1991. Yakima River Spring Chinook Enhancement Study Final Report. Project # 82-16.

Fisher, J.P. and K. McArthur. 2000. Cle Elum and Yakima River water intake diversion modifications: biological evaluation. Prepared for: City of Cle Elum. Prepared by: Pentec Environmental (Edmonds, WA).

Fries and Ryder, 1988. Retrospective Report on Bottom-Sediment Studies: NAWQA Surface Water Study, Yakima River Basin, Washington. USGS Open-File 88-45. USGS Menlo Park, California and Denver, Colorado.

Fuhrer et al., 1998a. Surface-Water-Quality Assessment of the Yakima River Basin in Washington: Spatial and Temporal Distribution of Trace Elements in Water, Sediment and Aquatic Biota, 1987-91. USGS Water-Supply Paper 2354-A.

Fuhrer et al., 1998b. Surface-Water-Quality Assessment of the Yakima River Basin in Washington: Distribution of Pesticides and Other Organic Compounds in Water, Sediment and Aquatic Biota, 1987-91. USGS Water-Supply Paper 2354-B.

Fulton, L. 1970. Spawning Areas and Abundance of Steelhead Trout and Coho, Sockeye and Chum Salmon in the Columbia River Basin – past and present. NMFS, Spec. Sci. Report. 618: 37p.

Haring D. 2001. Preliminary Review Draft of the “Habitat Limiting Factors by Subbasin”. Yakima Watershed Technical Advisory Croup Participants.

Hindman, J.H. et al, 1991. Yakima River Species Interaction Studies Annual Report FY 1990. Washington Department of Wildlife.

Hockersmith, E. et al., 1995. Yakima River Radio-Telemetry Study: Steelhead Annual Report 1989 – 1993. Coastal Zone and Estuarine Studies Division, Northwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Seattle, Washington.

Hockersmith, E. et al., 1994. Yakima River Radio-Telemetry Study: Spring Chinook Salmon Annual Report 1991 1992.

Hruby, T., W.E. Cesanek, and K.E. Miller. 1995. Estimating relative wetland values for regional planning. Wetlands 15(2):93-107.

Irving, D.B. and T.C. Bjornn. 1985. An inventory of stream sedimentation in selected Priest Lake tributaries. Moscow, Idaho: Idaho Cooperative Fish and Wildlife Research Unit, Fish and Wildlife Resources Dept., University of Idaho.

James, B.B. et al, 1999. Spring Chinook Salmon Interactions Indices and Residual/Precocial Monitoring in the Upper Yakima Basin Annual Report 1998. Washington Department of Fish and Wildlife, Olympia, Washington.

Joint Natural Resources Cabinet (JNRC). 2001. Guidance on Watershed Assessment for Salmon. Governor’s Funding Recovery Board. May, 2001.

Johnson et al., 1986. Occurrence and Significance of DDT Compounds and Other Contaminants in Fish, Water and Sediment from the Yakima River Basin. Washington Department of Ecology. Water Quality Investigations Section, Olympia, Washington.

Kreeger, K.E. and W.J. McNeil. 1993. Summary and Estimation of Historical Run Sizes of Anadromous Salmonids in the Columbia and Yakima Rivers. Unpublished report, prepared for Yakima River Basin Coalition.

McMichael, G.A. et al, 1992. Yakima River Species Interaction Studies Annual Report 1991. Washington Department of Fish and Wildlife.

McNeil, J.W. and Ahnell, W.H. 1964. Success of pink salmon spawning relative to size of spawning bed materials. U.S. Dept. of the Interior, Bureau of Commercial Fisheries.

Northwest Power Planning Council (NWPPC); Columbia Basin Fish and Wildlife Authority, October 31, 1988. Yakima Subbasin: Part II. Habitat Appendix A: Summary of Aquatic Habitat Provided by Major Reaches of Yakima and Naches Rivers and their Principal Tributaries.

Pearson, 1985. Hydrology of the Upper Yakima River Basin, Washington. State of Washington Department of Ecology and United States Geological Survey.

Pearsons, T.N. et al, 1996. Yakima River Species Interaction Studies Annual Report 1994. Washington Department of Fish and Wildlife, Olympia, Washington.

Phinney, D.D. 1999. Avian Predation on Juvenile Salmonids in the Yakima River, Washington. A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science, University of Washington, Seattle, Washington.

Rinella, et. al., 1992. Surface-Water-Quality Assessment of the Yakima River Basin, Washington: Pesticide and Other Trace Organic-Compound Data for Water, Sediment, Soil, and Aquatic Biota, 1987-91. USGS Open-File Report 92-644.

Smith, J.E. 1993. Retrospective Analysis of Changes in Stream and Riparian Habitat Characteristics Between 1935 and 1990 In Two Eastern Cascade Streams. A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science, University of Washington, Seattle, Washington.

Snyder E.B. and Stanford J.A. 2000. Review and Synthesis of River Ecological Studies in the Yakima River, Washington, With Emphasis on Flow and Salmon Habitat Interactions. Submitted to the U.S. Department of the Interior, Department of Reclamation. December 6, 2000.

Waldo, J.C. 2000. Yakima Basin Water Investment: An Action Agenda. Gordon Thomas Honeywell, Tacoma, Washington.

Washington Conservation Commission. 2001. Draft Limiting Factors Assessment on the Yakima River. May 8, 2001.

Washington Department of Fish and Wildlife and Western Washington Treaty Indian Tribes (WDFW & WWTIT). 1994. 1992 Washington State Salmon and Steelhead Stock Inventory (SASSI). Appendix one: Puget Sound Stocks, South Puget Sound Volume. Olympia, Washington.

Washington Department of Fish and Wildlife (WDFW). 1998. Washington's native chars [online report]. WDFW, Olympia. URL: http://www.wa.gov/wdfw/graywolf.htm.

Watson, B. 2001. Yakama Nation, personal communication. Regarding: EDT diagnostics for chinook salmon in the Yakima Watershed.

Watson, G. 1991. Analysis of Fine Sediment and Dissolved Oxygen in Spawning Gravels of the Upper Yakima River Basin. Washington Department of Fisheries.

WDOE. 1973. Washington State Department of Ecology. Water Quality Report – Yakima River December 1970 – September 1971. Technical Report No. 73-002. Olympia, Washington.

Yakama Nation 1997 *as cited in* Dunnigan, J.L. 2000. Yakima Coho Monitoring and Evaluation 1999 Annual Report. *prepared by*: James Dunnigan, Yakima Nation; *prepared for*: Bonneville Power Administration.

APPENDIX A:

YAKIMA PROJECT SCORING RATIONALE AND PROTOCOL

APPENDIX B:

ANNOTATED BIBLIOGRAPHY

red	YAKIMA RIVER ANNOTATED BIBLIOGRAPHY – BIOLOGY			
ID #	**Document title**	**Author – Source - Date**	**Contents**	**Comments**
001	Spring Chinook Salmon Interactions Indices and Residual/Precocial Monitoring in the Upper Yakima Basin Annual Report 1998	Prepared by: Brenda B. James et al, Washington Department of Fish and Wildlife Prepared for: USDE BPA Publication Date: December 1999	Study area: Lower Canyon, Cle Elum, Nelson, Easton, North Fork Teanaway (shown pg 2, fig 1) Competitors include: - Mountain whitefish, reside shiner, rainbow trout **Chapter 1:** Prey and competition indices of juvenile spring chinook salmon (Purpose – calculate baseline indices of Prey, Food, Space) Tables include info on gut fullness, food and space competition indices btwn age-0 chinook and competitor species, summary of spring chinook salmon abundance and densities. **Chapter 2:** Microhabitat utilization of spring chinook salmon – using the currently low densities of age-0 chinook in the upper Yakima as baseline data set to indicate preferred microhabitat, range or variations of habitats used in three areas of the Yakima River – methods: fish counts in pods (snorkeling). Tables 1,2: microhabitat variations, water temp/season. Microhabitat was noted for each marker (deep pool, shallow pool, run, etc.), instream cover, velocities, distance to nearest bank were also noted. Table 1: Microhabitat variable measured for spring chinook, rainbow trout, redside shiners, & mountain whitefish… Table 2: Summary of dates, range of H20 temp during data collection… Table 3: Summary of summer and fall microhabitats used by age-0 spring chinook (all sites pooled)… Table 4: Summary of microhab parameters used by age-0 spring chinook during summer, depths and velocities… Table 5: Results of ANOVA test comparing summer microhabitat variables btwn study sections for age-0… Table 6: Summary of microhabitat used by age-1+ spring chinook, age-0 and age-1+ bows, mt. Whitefish (pooled)… Table 7: Results of student's t-tests comparing microhabitat variables btwn summer and fall for age-0… Table 8: Mean absolute differences btwn head/tail microhabitat positions and btwn left/rt positions held by age-0 **Chapter 3:** Abundance of residual and precocial spring chinook salmon Tables include summary of sections, dates and temps of residual and precocial observations, density of res. Chinook per linear meter, and per age-0 chinook, summary of precocial chinook activity on redds…	Sections: Nelson – 7.2 km below Easton Dam btwn WDFW access ramp (river km 314.6) and the I-90 bridge (river km 307.4) Cle Elum – 8.8 km flows past Cle Elum from S. Cle Elum bridge (river km 294.5) to river km 285.7. Upper Canyon – 4.8 km south of Ellensburg from Ringer Road access (river km 238.2) to Bighorn (river km 233.4) Chapter 2: references a similar study conducted in 1990 by Payne and Associates (1995).
002	Yakima River Species Interaction Studies Annual Report FY 1990	Prepared by: James H. Hindman et al, Washington Department of Wildlife Prepared for: USDE – BPA	**Executive Summary (ii):** species interaction study implemented to investigate possible effects of supplementation (with anadromous species) on resident fish populations in the upper Yakima River basin. Spawning surveys (electrofishing and snorkeling) were conducted on the Upper Yakima River and 13 tributaries btwn Roza and Keechelus dams. Field activities: Dec 1989 to June 1990. By June 30, data indicated greatest number of large spawning rainbow occurred in lower mainstem and lower elevation tribs (Umatanum, Cherry, Wilson, Naneum Creeks). Higher elevation tribs and mainstem areas contained fewer and smaller (not nec. Younger) trout – most of the current anadromous fish (steelhead, chinook) spawning is known to occur here. Preliminary data indicates few large rainbows utilize upper Yakima for spawning.	**Study Area:** Mainstem Yakima River btwn Roza Dam rkm 180) and Keechelus Dan (rkm 305). (See figure 1 – map)

red	YAKIMA RIVER ANNOTATED BIBLIOGRAPHY – BIOLOGY			
ID #	**Document title**	**Author – Source - Date**	**Contents**	**Comments**
		Publication Date: February 1991	**Specific goals for this report: 1)** determine timing and distribution of resident trout spawning activities in the mainstem Yakima River and in major tributaries. **2)** determine age-comp, length-at-age characteristics, sex ratio and growth rates of spawning pop thru bio data collection **3)** invest. seasonal distribution and movement patterns of adult salmonids via observation of tagged individuals. **4)** genetic asses samples 3 General Goals for each report phase: **1)** Collection of baseline info on fish populations in upper Yakima River and Tributaries, spawning surveys **2)** investigate interactions btwn trout and anadromous salmonids to assess potential impacts of supplementation prior to releases of juveniles and returning adults from the YKPP (Yakima/Klickitat Production Program) and **3)** Monitor and assess the status of resident trout after implementation of YKPP supplementation This report contains 8 tables summarizing spawning and snorkeling surveys, and mean lengths, weights, condition factors, length-at-age characteristics for rainbows, etc. Fourteen figures are included showing maps, mean weekly discharge, water temp, and length frequency of rainbows in each tributary sampled.	
003	Yakima River Species Interaction Studies Annual Report 1991	Prepared by: Geoffrey A. McMichael et al, Wash Dept Wildlife Prepared for: USDE, BPA October 1992		
004	Yakima River Species Interaction Studies Annual Report 1994	Prepared by: Todd N. Pearsons et al, WDFW Prepared for: USDE – BPA Publication Date: September 1996	**Executive Summary:** 5th series of annual reports – species interactions and pre-facility monitoring of fishes in upper Yakima River basin Major topics of this report: life history of rainbow trout, interactions experiments, and methods. Major preliminary findings include: - 1) age 0+ rainbow and spring chinook were associated with bank habitats in the Yakima during spring, summer, and fall – few observed in the middle of either mainstem or side channel habitats. 2) The number of fish/fish species captured in Swauk Creek and immigration of rainbows and spring chinook decreased with increasing elevations – annual variations in assemblage structure did not appear to differ among sites. 3) Spatial distribution of rainbow redds in Yakima River was patchy – most observed in reaches with unconstrained channels and abundant instream cover. 4) Large tagged rainbows tended to move downstream more often than upstream, but more fish were recaptured at upper elevations. 5) Temporal variability of rainbow trout abundance in tributary index sites ranged from stable to highly fluctuating. Average (1994) densities	

red ID #	Document title	Author – Source - Date	Contents	Comments
			ranged from 0.12/m^2 (Swauk Crk) to 0.01/m^2 (Cabin Crk). Trout densities in 5 index sections of the Yakima averaged 297/km during 1994 and were not as temporally variable as tributary sites. All juvenile s.chinook were observed in sites less than 730 km elevation. 6) Variation in assemblage structure was larger in space than in time in tributary and mainstem index sites (as in previous data) 7) Hatchery-reared steelhead released into the Nfork Teanaway subbasin behaviorally dominated rainbows probably due to their larger size. Displacement of wild trout by hatchery steelhead within channel units; densities and biomasses of wild rainbows appears negatively influenced by hatchery steelhead. Residual steelhead were relatively abundant in 1994 and were released in an area containing wild bull and rainbow trout. 8) Results from competition experiments performed in N and Middle Forks Teanaway River suggest: 1) hatchery-reared steelhead negatively impacted growth of naturally produced rainbow but not of chinook 2) hatchery-reared chinook negatively impacted growth of wild chinook, and 3) wild chinook did not impact the growth of wild rainbows. **Chapter 1**: Species and habitat associations of spring chinook salmon and rainbows in the upper Yakima River (4 figures, 7 tables) **Chapter 2**: Movement of fishes along an elevation gradient within Swauk Creek (7 figures, six tables) Update 1: Rainbow Trout temporal and spatial spawning distribution in the upper Yakima River basin, and their redds (2 tables) Update 2: Movement of resident rainbow trout within the Upper Yakima River basin (1 figure, 1 table) Update 3: Salmonid distribution and rainbow trout population abundance variation in the upper Yakima basin (10 figures, 11 tables) Update 4: Species associated with rainbow trout and spring chinook salmon in the upper Yakima basin (4 tables) Update 5: The effects of releases of hatchery-reared steelhead on wild salmonids in natural streams (7 figures, 3 tables) Update 6: Studies of hatchery and wild steelhead, rainbow trout, and chinook salmon paired in instream enclosures (11 tables) Update 7: Effects of parentage, rearing density, and size at release of hatchery-reared steelhead smolts on smolt quality and post-release performance in natural streams (3 tables) **Appendix A**: Temporal and spatial variation in the condition of hook-scarred rainbow trout in the Yakima River (4 figures, 2 tables)	

red	YAKIMA RIVER ANNOTATED BIBLIOGRAPHY – BIOLOGY			
ID #	**Document title**	**Author – Source - Date**	**Contents**	**Comments**
005	Yakima Basin Water Investment: An Action Agenda	Prepared by: James C. Waldo October 30, 2000	Letter to Governor Gary F. Locke – recommendation that 63 proposed projects be implemented in the near-term This report contains a spreadsheet listing each recommended proposed project with a brief summary of each project.	
006	Missing Title Page	Prepared by: Busby et al	Goes through the Yakima River basin, Fisheries resources, Resident salmonids, non-resident salmonids, stream catalog set-up, mainstream reaches (upper, middle, lower), Mainstem reach catalog (through each reach) Gives specific info pertaining to each area, reach, stream etc.	
007	Yakima River Radio-Telemetry Study: Spring Chinook Salmon Annual Report 1991 – 1992	Prepared by: Eric Hockersmith et al Prepared for: USDE, BPA September 1994	Introduction: In 1991, the National Marine Fisheries Service (NMFS) began a 2-year radio-telemetry study of adult spring chinook salmon in the Yakima River Basin. Specific objectives: **1)** Determine spawning populations' run timing, passage patterns at irrigation diversion dams, and morphometric characteristics to determine where and when substocks become separated. **2)** Evaluate fish passage at Yakima River basin diversion dams including Prosser, Sunnyside, Wapato, Roza, Town Diversion, Easton , Cowiche, and Wapatox Dams. **3)** Determine spring chinook migration rates between Yakima River basin dams, prespawning behavior, temporal distribution, and habitat utilization. **4)** Identify spawning distribution and timing of chinook. **5)** Determine amount and cause of prespawning mortality of chinook. **6)** Evaluate adult fish-handling procedures for the right-bank, adult-trapping facility at Prosser Dam. Discussion:	
008	Yakima River Radio-Telemetry Study: Steelhead Annual Report 1989 - 1993	Prepared by: Eric Hockersmith et al Prepared for: USDE, BPA January 1995	Introduction: In 1989, the National Marine Fisheries Services (NMFS) began a 4-year radio-telemetry study of steelhead in the Yakima River Basin. Objectives: **1)** Determine running time, passage patterns at irrigation diversion dams, and morphometric characteristics of different Yakima Basin steelhead substocks and determine where and when the substocks became separated. **2)** Evaluate adult steelhead passage at Yakima River Basin diversion dams including Prosser, Sunnyside, Wapato, Roza, Cowiche, and Wapatox Dams. **3)** Determine steelhead migration behavior, temporal distribution, and habitat utilization in the Yakima River Basin. **4)** Identify spawning distribution and timing of steelhead. **5)** Determine the amount and cause of pre-spawning mortality of radio-tagged steelhead.	
009	Yakima River Spring Chinook Enhancement Study Final Report May 1991	Prepared by: David Fast, et al, Yakima Indian Nation Fisheries Resource Management Prepared for: Thomas Vogel, USDE – BPA Project # 82-16		

red	YAKIMA RIVER ANNOTATED BIBLIOGRAPHY – BIOLOGY			
ID #	**Document title**	**Author – Source - Date**	**Contents**	**Comments**
010	Avian Predation on Juvenile Salmonids in the Yakima River, Washington A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science, University of Washington	Prepared by: David Duane Phinney 1999	Avian predation was studied from fall 1997 to summer 1998 with emphasis on spring chinook rearing areas. Index sections were established in free-flowing stretches to determine abundance of avian predators in each chinook rearing area…methods Avian predation was low in lower river during the spring smolt outmigration. Summer observations in the upper river suggested that common mergansers and broods may consume large numbers of non-migrating chinook fry. Fall and winter observations suggested mergansers were major avian predator of rearing spring chinook. Numerous "hot spots" were studied, but predation was highest at the Chandler Canal bypass outfall and at Horn Rapids Dam (both sites in lower 50km of river)..(not done going through this – located SOUTH of us)	This seems to be located near the Columbia River / Yakima River confluence – SOUTH of us.
011	Yakima Fisheries Project – Revised Draft Environmental Impact Statement (DOE/EID-0169)		BPA proposed to fund the Yakima Fisheries Project (YFP) to undertake fishery research and enhancement activities in the Yakima River Basin.	NOT DONE
012	Yakima River Basin Fisheries Project Draft Environmental Impact Statement	October 1992		
013	Yakima Fisheries Project Revised Draft Environmental Impact Statement - Summary	May 1995		
014	Retrospective Analysis of Changes in Stream and Riparian Habitat Characteristics Between 1935 and 1990 In Two Eastern Cascade Streams A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science, University of Washington	Prepared by: J.E. Smith June 9, 1993		

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ID #	**Document title**	**Author – Source - Date**	**Contents**	**Comments**
001	Water Quality Report – Yakima River December 1970 – September 1971. Technical Report No. 73-002	State of Washington Department of Ecology. May 1973.	THIS REACH OF THE YAKIMA RIVER IS DOWNSTREAM OF THE CITY OF YAKIMA Water quality report documenting data collected during the time period December 1970 – September 1971 for the Yakima River and Wide Hollow Creek. <u>December 1970 – March 1971 Summary</u>: Water quality for this period in 1970 was significantly poorer than in recent years (See Table 3). Increases were observed in coliform densities, conductivity and nitrates. Decreases occurred in pH and dissolved oxygen. Water quality was reported to have improved when compared to the same time period of the following year (1971), The fluctuations observed could not be explained because “abnormal municipal, domestic, or industrial loads were not reported and the river flows were similar. <u>December 1970 – March 1971 Details</u>: most significant pollution was elevated bacterial concentrations; samples from 35 stations located along the Yakima River (between ? and ?) violated either median or maximum limit condition specified in the Class A or Class B coliform standard; identified high bacterial inputs from Wide Hollow Creek and from the “discharge of fecal material” between Terrace Heights and Parker; another area of localized high coliform measurements was near Kiona (attributed to “municipal and industrial discharges” in the vicinity of Prosser); a general trend of nutrient enrichment (phosphate and nitrate) was observed as the water flowed through the Basin; elevated ammonia levels were observed in the vicinity of Snokist Growers/Yakima, (???), and (???). Specific point sources are not identified. Yakima River water was “moderately soft” with 73% of cations being calcium and 81% of the anions being bicarbonate. Wide Hollow River showed similar, but more degraded water quality, versus the Yakima River. Coliform densities and concentrations of nitrates and phosphates were significantly higher. Specific point sources are not identified. <u>April 1971 – June 1971 Summary</u>: similar to what was observed in Dec 1970-March 1971, a trend towards lower water quality was observed; high nitrate and coliform bacteria values (but less dramatic than in Dec 1970-March 1971), probably less dramatic due to dilution effect of spring runoff. <u>April 1971 – June 1971 Details</u>: very similar to results observed December 1970 – March 1971 Details:	
002	Analysis of Fine Sediment and Dissolved Oxygen in Spawning Gravels of the Upper Yakima River Basin	Greg Watson – Washington Department of Fisheries February 1991	<u>Background</u>: a number of studies have shown a correlation between the ratio of fine sediments in spawning gravels and the survival of salmonid embryos in redds (McNeil and Ahnell, 1964; Cooper 1965; Irving and Bjornn, 1985). Reason for effect may be that fine sediments prevent the delivery of well-oxygenated water to embryos (by clogging inter-gravel spaces) and/or restrict the escapement of alevins from the redd via cementation. Also, studies have shown correlation between extent of forest-related activities (logging and road construction) and the accelerated delivery of fine sediment to streams within the watershed. Further, McNeil and Ahnell (1964) and Irving and Bjornn (1985) have indicated that salmonid survival to emergence decreases	

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			significantly when fine sediments (<1.0 mm diameter) in spawning substrate exceeds 20%. <u>Stated Objective:</u> " to determine existing levels of fine sediment, geometric mean particle size, and dissolved oxygen in spawning gravels which will be used for making management decisions related to timber harvest as agreed to by YRMP participants." <u>Sampling sites</u> Samples were collected from three (3) spawning riffles from each of the following tributaries: Big Creek, Taneum Creek, North Fork Taneum Creek, West Fork Teanaway River, North Fork Teanaway River, Middle Fork Teanaway River, Cabin Creek, Cole Creek, Little Creek, Box Canyon Creek, French Cabin Creek, Gold Creek, Kachess River, Cle Elum River, Mineral Creek, North Fork Manastash Creek, South Fork Manastash Creek, Log Creek. <u>Sampling Dates</u>: mid-August 1990 through mid-October 1990. **<u>Findings</u>:** a weak, non-significant negative correlation between DO and percent fine sediment *Sediment Results – Summarized in Table 1* **"Red Light" Tributaries** (statistically significant exceedances of sediment screening threshold of >25% fines <1.0 mm): North Fork Manastash Creek **"Yellow Light" Tributaries** (approaching statistical exceedances of sediment screening threshold i.e., >15% fines <1.0 mm): Cabin Creek, Cole Creek, Gold Creek, Little Creek, South Fork Manastash Creek, Taneum Creek, North Fork Taneum Creek. Tributaries for which statistical exceedances of sediment screening threshold were not yet evident: Big Creek, West Fork Teanaway River, North Fork Teanaway River, Middle Fork Teanaway River, Box Canyon Creek, French Cabin Creek, Kachess River, Cle Elum River, Mineral Creek, Log Creek. <u>DO Results – Summarized in Table 4</u> The following tributaries had reported DO values of <90% saturation: Log Creek, North Fork Manastash Creek, South Fork Manastash Creek, Taneum Creek.	

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003	Occurrence and Significance of DDT Compounds and Other Contaminants in Fish, Water and Sediment from the Yakima River Basin	Johnson et al., July 1986. WA Department of Ecology	Reports analyze concentrations in fish, water and bed sediments collected from four river locations (Cle Elum, Wymer, Buena and Kiona/Benton City) and a number of tributaries. Collected resident fish as well as spring Chinook and out-migrating juvenile salmonids; analyzed whole fish, muscle and eggs. <u>Only Cle Elum and Wymer are located upstream of the city of Yakima.</u> **<u>Analytes:</u>** DDx, 15 additional persistent organochlorine pesticides, PCBs and mercury. **<u>Fish Tissue Findings:</u>** Major OC analytes detected were DDT, DDE, dieldrin, and Aroclor 1260. Concentrations higher in lower river than in upper river. Salmonid concentrations substantially lower than resident species. Total DDx, dieldrin, Aroclor 1260, and mercury in tissue were below FDA action levels (5,000 ppb DDx; 300 ppb dieldrin; 2,000 ppb PCBs; 1,000 ppb Hg). All concentrations in eggs were below literature-based "effects thresholds" Risk to upper trophic level receptors (i.e., piscivorous birds) was assessed by comparing fish tissue data to Nat Acad Science maximum recommended concentrations: only DDx <u>AT KIONA</u> exceeded NAS recommendations. **<u>Water Sample Findings:</u>** DDT, DDD, DDE, dieldrin and endsulfan were detected, but almost exclusively in tributaries (DDE and dieldrin were detected only once in the main stream). <u>Sulfur Creek, Birchfield Drain, Granger Drain, and Spring/Snipes Creek</u> were identified as sources of DDx. Sulfur Creek was greatest contributor. Six tributaries were identified as sources of dieldrin. Endosulfan detected only in Birchfield Drain. The <u>maximum combined loads</u> for these compounds were: 0.1 lb/d DDx; 0.03 lb/d dieldrin; 0.05 lb/d endosulfan. **NOTE: All of these tributaries are DOWNSTREAM of Yakima.** Detected concentrations for tributaries were below acute toxicity values for aquatic life, but above some chronic values. **<u>Sediment Sample Findings:</u>** DDx and dieldrin were predominant organochlorines detected in Yakima River bed sediments. Maximum concentrations were detected in sediments from Sulfur Creek (234 ppb DDx; 14.9 ppb dieldrin). One high hit of aldrin (1,065 ppb) was resent in sediment sample from Spring/Snipes Creek. Both of these tributaries are DOWNSTREAM of Yakima.	Highest detected concentrations and tributaries identified as sources are ALL located south of the City of Yakima (i.e., outside of our Upper Yakima Basin study area).

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			Conclusions: Source of DDx in Yakima River Basin is primarily historical (rather than from illegal use) These results and results of USGS studies indicate that transport of DDx and dieldrin occurs primarily during irrigation season. Erosion control measures are recommended to reduce losses of DDx and dieldrin from agricultural land. **<u>Noteworthy Figs/Tables:</u>** Table 1: DDx fish tissue data available as of early 1985. Table 5: Analytes and analytical detection limits. Table 11: Concentrations of OC pesticides, PCBs and Hg in whole fish and mussel samples from Yakima River stations (1985). Table 12: Concentrations of OC pesticides, PCBs and Hg in fish and crayfish samples from Yakima River stations (1985). Table 13: Concentrations of OC pesticides, PCBs and Hg in fish egg samples from Yakima River stations (1985). Table 14: Summary of Concentrations of OC pesticides, PCBs and Hg in fish and invertebrate samples from Yakima River stations (1985). Table 15: Concentrations of OC pesticides, PCBs and Hg in water samples from Yakima River and tributary stations (1985). Table 16: Concentrations of OC pesticides, PCBs and Hg in bed sediment samples from Yakima River and tributary stations (September 1985). Table 22: Summary of references reporting effects of OC residues in fish eggs and fry. Table 23: OC pesticide loads measured in Yakima River and tributaries (1985). Figure 4: Comparison of Yakima River fish and invertebrate sample DDx, dieldrin, Aroclor 1260 and Hg concentrations to FDA action levels. Figure 5: Comparison of Yakima River whole fish and invertebrate sample DDx, dieldrin, Aroclor 1260 and Hg concentrations to NAS recommended maximum concentrations.	

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004	Surface-Water-Quality Assessment of the Yakima River Basin, Washington: Pesticide and Other Trace-Organic-Compound Data for Water, Sediment, Soil, and Aquatic Biota, 1987-91	Rinella, et. al., 1992 USGS Open-File Report 92-644	Report of analytical data describing concentrations of chemical constituents in stream water, suspended sediments, bed sediment, soil, and aquatic biota collected from the Yakima River Basin (1987-1991). **Constituents include one or more of the following:** organochlorines, semi-volatiles, organophosphates, triazines, carbamates, chlorophenoxy acids, volatiles, phenols/cresols, and polycyclic aromatic hydrocarbons (PAHs). The report presents data in dozens of Tables (not yet copied).	
005	Retrospective Report on Bottom-Sediment Studies: NAWQA Surface Water Study, Yakima River Basin, Washington	Fries and Ryder, 1988. USGS Open-File 88-45	Presents review of existing studies of bottom sediment geochemistry in the Yakima River Basin. Data from these studies was evaluated for use in the NAWQA study to be carried out in the Yakima River Basin. However, existing studies were found to be inadequate for use in basin-wide evaluation of the relationship between water quality and bottom-sediment geochemistry. Cannot tell by what's in-hand whether useful chemistry data are provided.	
006	Hydrology of the Upper Yakima River Basin, Washington	Pearson, 1985. WA Dept of Ecology and USGS, 1985	Report provides a summary of historical information regarding the following for the Upper Yakima River Basin: Description of the Basin; Water Budget; Surface water resources, streamflow characteristics, and water quality; Ground water resources, water level fluctuations, and water quality; and, Water use.	
007	Surface-Water-Quality Assessment of the Yakima River Basin in Washington: Spatial and Temporal Distribution of Trace Elements in Water, Sediment and Aquatic Biota, 1987-91.	Fuhrer et al., 1998 USGS Water-Supply Paper 2354-A	Report of analytical data describing concentrations of trace elements in stream water, suspended sediments, bed sediment, soil, and aquatic biota collected from the Yakima River Basin (1987-1991). Examined spatial and temporal distribution of trace elements in the aquatic environment. Also, examined temporal variations in concentrations in aquatic biota sampled at sites in common in 1989 and 1990. **Constituents included the following:** Sb, As, Pb, Ba, Cd, Cr, Ni, Co, Cu, Hg, Se, Ag, Zn. **Findings:** 1) Most element enrichment in the Yakima River Basin results form natural geologic sources in the forested landscapes of the Kittitan and mid-Yakima Valley – primarily in the Cle Elum, Upper Naches, Teanaway and Tieton Subbasins. These subbasins typically have water and sediment concentrations of As, Cr, Ni, etc that are 4- to 100-times greater than in areas	

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			farther downstream in the Yakima River Basin. 2) Distribution of element concentrations that increase in areas affected by human activities include As, Cd, Cu, Pb, He, Se, and Zn. 3) Loads of As associated with agricultural practices increase dramatically during the irrigation season (primary sources are the Sulfur Creek Wasteway and Wide Hollow Subbasin, both of which are downstream of the City of Yakima). 4) Comparisons between suspended and dissolved As loads indicate that the annual dissolved-arsenic loads at fixed sites in the lower Yakima Valley are form 4- to 9-times higher than their respective suspended loads. 5) Fish taxa provide the most comprehensive spatial coverage of As, Hg, and Se; however no single fish taxon is widely distributed across the Yakima River Basin. 6) Concentrations of several elements including Cd, Hg and Se in various taxa were higher in the main stem of the lower Yakima Valley than in the Kittitas and mid-Yakima Valley. The report presents a very large amount of data in dozens of Figures and Tables, including: **Table 6:** Provides a comparison of streambed sediment analytical data to water-quality guidelines (lowest effect levels and severe effects levels) developed by the Water Resource Branch of the Ontario Ministry of the Environment, Canada (Persaud et al., 1993). **Table 7:** Provides a comparison of filtered surface water analytical data to water-quality guidelines (lowest effect levels and severe effects levels) developed by the Water Resource Branch of the Ontario Ministry of the Environment, Canada (Persaud et al., 1993). **Table 8:** Provides a comparison of unfiltered surface water analytical data to water-quality guidelines (lowest effect levels and severe effects levels) developed by the Water Resource Branch of the Ontario Ministry of the Environment, Canada (Persaud et al., 1993).	
008	Surface-Water-Quality Assessment of the Yakima River Basin in Washington: Distribution of Pesticides and Other Organic Compounds in Water, Sediment and Aquatic Biota, 1987-91.	Fuhrer et al., 1998 USGS Water-Supply Paper 2354-B	Report of analytical data describing concentrations of pesticides and other organic compounds in stream water, suspended sediments, bed sediment, soil, and aquatic biota collected from the Yakima River Basin (1987-1991). Examined distribution of pesticides in the aquatic environment (water column, sediment bed, aquatic biota). Examined relations of compound concentrations among sampled media Examined relations between water-quality conditions and pesticide use.	

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			<u>Constituents included the following:</u> DDT and metabolites (DDx), PCBs, chlordane-related compounds, dieldrin, toxaphene, dicofol, an PAHs The report presents data in dozens of Tables. **<u>NOTE</u>**: the data presented and discussed in this report is very likely the same data that was reported/discussed in document #4 above.	
009	Distribution of Fish, Benthic Invertebrate, and Algal Communities in Relation to Physical and Chemical Conditions, Yakima River Basin, Washington, 1990.	Cuffney et al., 1997. USGS Water Resources Investigations Report 96-4280.	Report produced as part of the National Water-Quality Assessment Program (USGS). Ecological surveys were conducted at 25 sites in 1990 including 14 upstream of the City of Yakima. Of these, 5 sites were located on the Naches River or tributaries and 9 were located on the Yakima River or tributaries. **<u>Goals:</u>** 1) to assess water quality conditions based on fish, benthic invertebrate, and algal communities; 2) determine the hydrologic, habitat, and chemical factors that affect the distributions of these organisms; and 3) relate physical and chemical conditions to water quality. <u>Chemical constituents</u>: metals and organopesticides in surface water, suspended sediment, bed sediment, and fish tissue. **<u>Findings:</u>** 1) Fish communities of headwater streams in the Cascades (upstream extreme of Yakima and Naches Rivers and tributaries) and Eastern Cascades (mid-reaches of the Naches R. and tributaries) ecoregions of the Yakima River Basin were primarily composed of salmonids and sculpins, with cyprinids dominating in the rest of the basin; 2) The most common of the 33 fish species taxa collected were speckled dace, rainbow trout, and Paiute sculpin; 3) Invertebrates presented the highest number of taxa (193), with sensitive insect species (e.g., mayflies, stoneflies, and caddisflies) formed the majority of the invertebrate communities of the Cascades and Eastern Cascades regions; 4) Diatoms dominated algal communities throughout the basin (134 algal taxa were found on submerged rocks, the only stream microhabitat sampled); 5) Sensitive red algae and diatoms predominated in the Cascade and Eastern Cascade ecoregions, whereas the abundance of eutrophic diatoms and green algae was large in the Columbia Basin ecoregion (mid- and lower-reaches of the Yakima River and tributaries, and lower reaches of the Naches R. and tributaries) of the Yakima River Basin. 6) Ordination of physical, chemical and biological site characteristics indicated that elevation was the dominant factor determining the distribution of biota; agricultural intensity and stream size were of secondary importance;	

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			7) Three community types were identified by ordination: a) high elevation, cold-water communities associated with low agricultural intensity; b) lower elevation, warm-water communities associated with low agricultural intensity; and, c) lower elevation, warn-water communities associated with moderate to high agricultural intensity; 8) Multimetric community condition indices indicated that Cascade and Eastern Cascade sites were largely unimpaired; however, all but 2 sites in the Columbia Basin site group were impaired; 9) Agriculture (nutrients and pesticides) was the primary factor responsible for this impairment, and all impaired sites were characterized by multiple indicators of impairment. 10) Large-river group sites downstream of the City of Yakima were all moderately to severely impaired; 11) High levels of impairment at large-river sites corresponded with high levels of pesticides in fish tissues and the occurrence of external abnormalities; 12) Response exhibited by invertebrates and algae to a gradient of agricultural intensity suggested a threshold response for sites in the Columbia Basin site group: community conditions declined precipitously at sites with moderate agricultural intensity and showed little response to higher levels of agricultural intensity. This pattern of response suggested that mitigation efforts conducted at sites with high levels of agricultural intensity not produce meaningful improvement in invertebrate and algal community conditions. In contrast, relatively moderate mitigation effort s at sites where the level of agricultural intensity is near to the impairment threshold will probably produce large improvements in community conditions at relatively modest costs.	
010	Anthropogenic Alterations to an Alluvial Floodplain within the Yakima River Basin, Washington.	Eitemiller, 2000. Univ Central WA. August 2000.	Discusses the effects human activities (e.g., road and levee development, dams and storage reservoirs) have had on the physical connectivity of the river to the riverine environment. This document, however, only discusses these changes for the reach of the Yakima River from the City of Yakima downstream to Union Gap. According to the authors, the evaluation of ten other reaches of the Yakima River is currently ongoing.	
011	Yakima Subbasin: Part II. Habitat Appendix A: Summary of Aquatic Habitat Provided by Major Reaches of Yakima and Naches Rivers and their Principal Tributaries	Northwest Power Planning Council; Columbia Basin Fish and Wildlife Authority. October 31, 1988.	Document provides detailed descriptions of specific reaches of the Yakima River and Naches River and their principal tributaries with respect to habitat quality, water quality, water flows, impediments to fish movements, and potential/historical use of the reach as spawning/rearing grounds for anadromous fish species. Of note, the authors occasionally identify those locations where mitigation/restoration efforts would likely improve/expand the extent of habitat suitable for anadromous fish reproduction, etc. Many of the areas described in this document are located within the study area. However, the information and descriptions, while of great detail and being very informative, may have limited applicability due to their “dated-ness” (i.e., publication year = 1988).	

	HYDROLOGY		HYDROLOGY / WATER QUANITITY
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001	Yakima Basin Water Investment: An Action Agenda	Prepared by: James C. Waldo October 30, 2000	Letter to Governor Gary F. Locke – recommendation that 63 proposed projects be implemented in the near-term This report contains a spreadsheet listing each recommended proposed project with a brief summary of each project.
002	Velocity Measurements at Three Fish Screening Facilities in the Yakima Basin, Washington Summer 1989 Annual Report 1989	Prepared by: C. Scott Abernethy et al, Pacific Northwest Laboratory September 1990	Measured velocities at 3 fish screening facilities (Wapato, Chandler, Easton) in the Yakima River Basin. Objectives: 1) Wapato: approach and sweep velocities measured to evaluate the effect of rearing pens in the screen forebay. 2) Chandler: complete survey performed 3) Easton: velocity was measured behind screens to provide info for the installation of porosity boards to balance flow through screens. Introduction: Improvement of fish screening facilities in irrigation canals is a major component in the overall fisheries enhancement program. Summary: 1) Wapato Screens: velocity measurements taken before and after removal of 3 salmo-rearing pens from the screen forebay indicated that although the pens have only a minimal effect on actual approach and sweep velocities at the face of the drum screens, the pens contributed to increased turbulence and instability of the water flow. Swirls and turb at the drum face screens couls result in intermittent increases in approach velocities. The net pens did not appear to affect flow through the 3 fish bypasses. 2) Chandler Screens: Low sweep velocities and elevated approach velocities under drum screen curvature result in velocity conditions that do not meet design criteria standards.